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THIS BASIC READER IS A PART OF AN EXPERIMENTAL CURRICULUM DEVELOPMENT PROJECT DESCRIBED IN VT 004 454, TO DEVELOP AND EVALUATE SPECIAL NEW TRAINING MATERIALS TO TEACH BASIC VOCATIONAL TALENT SKILLS TO DISADVANTAGED STUDENTS WHICH WERE TESTED ON APPROXIMATELY 2,500 EIGHTH AND NINTH GRADERS IN EIGHT SCHOOL SYSTEMS ACROSS THE NATION. THIS READER WAS DESIGNED TO PROVIDE INFORMATION ABOUT BASIC PRINCIPLES, CONCEPTS, AND APPLICATIONS OF MECHANICS AND TECHNOLOGY. IT CONTAINS ILLUSTRATIONS AND TEXT FOR 36 HAND TOOLS, NINE POWER TOOLS, 10 FASTENING DEVICES, EIGHT BASIC MACHINES, SIX TRACTORS, AND 19 PIECES OF FARM TRACTOR EQUIPMENT. THE MATERIAL WAS ADAPTED FROM MILITARY AND MANUFACTURERS' PUBLICATIONS. OTHER RELATED DOCUMENTS ARE VT 004 455 THROUGH VT 004 471. (EM)

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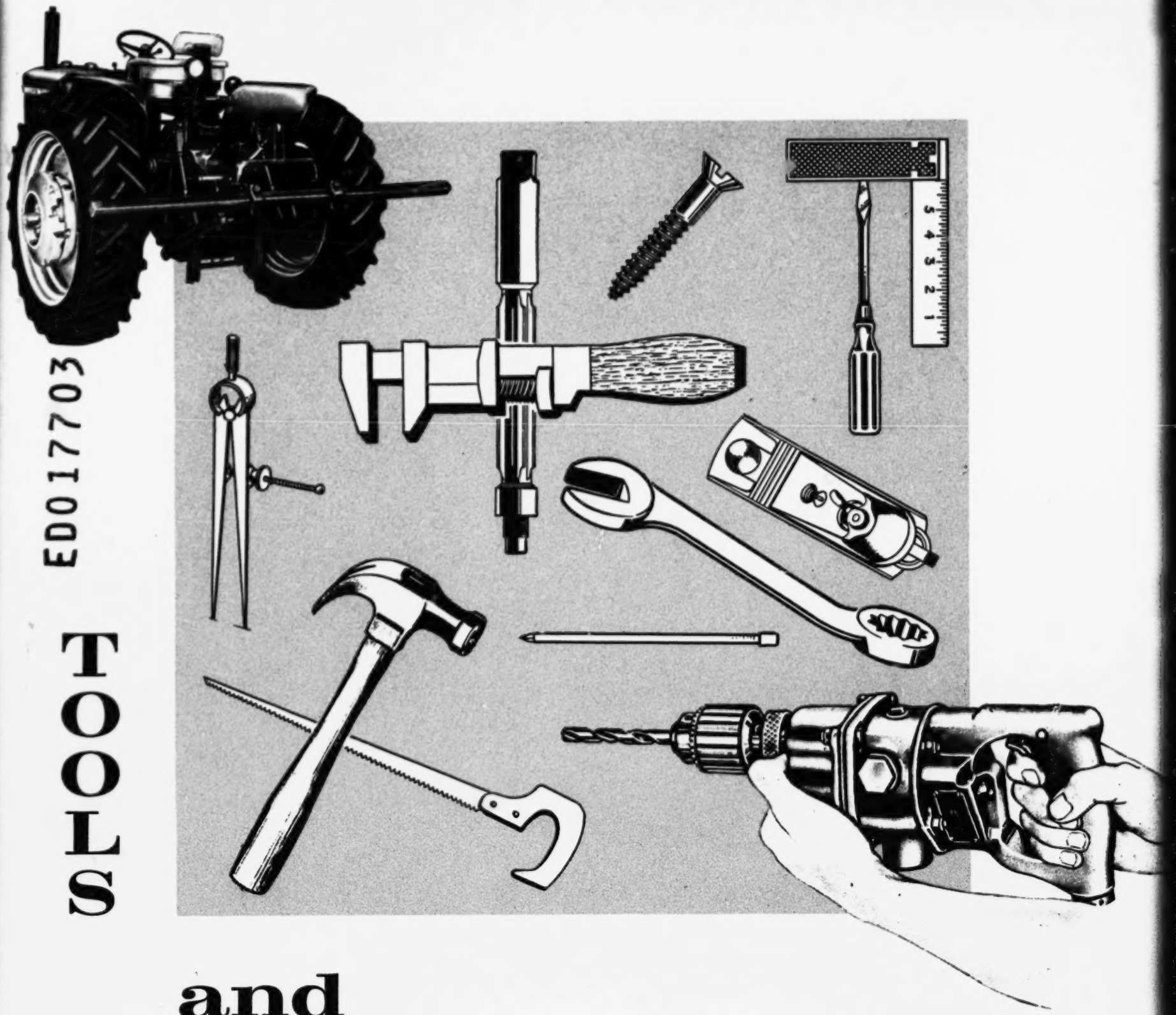
TOOLS



and

BASIC MACHINES

The George Washington University
School of Education
Education Research Project
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TOOLS AND BASIC MACHINES

THE GEORGE WASHINGTON UNIVERSITY
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Education Research Project
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April 1966

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TOOLS AND BASIC MACHINES

INTRODUCTION

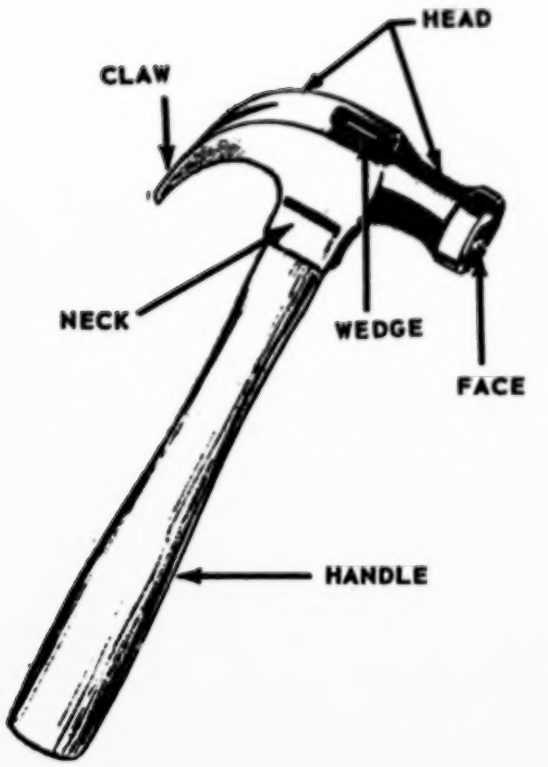
Every day the mechanical things around us are getting more complicated. Today's automobile is very different from the Model T Ford. Today's airplane is much more complicated than the one flown by the Wright brothers not so long ago.

Yet in spite of this increasing complexity, almost everything about us starts from simple hand tools. A knowledge of these hand tools increases our ability to work with mechanical things. Hand tools are very important to our modern civilization.

This booklet shows pictures of a few of the many hand tools that exist. A brief description is given of the way each of them is used. One section gives pictures and descriptions of a few power tools. The section about nails, screws, bolts, and other simple fasteners describes things usually used with hand tools.

In order to put tools to work it is necessary to know a few simple principles about machines. The study of these principles is necessary for the engineer and the technician. Only the most basic of these principles and their application are given here.

The last part of the booklet is intended to show how these basic principles are put to work. Farm machines utilize many of the mechanical principles described here.



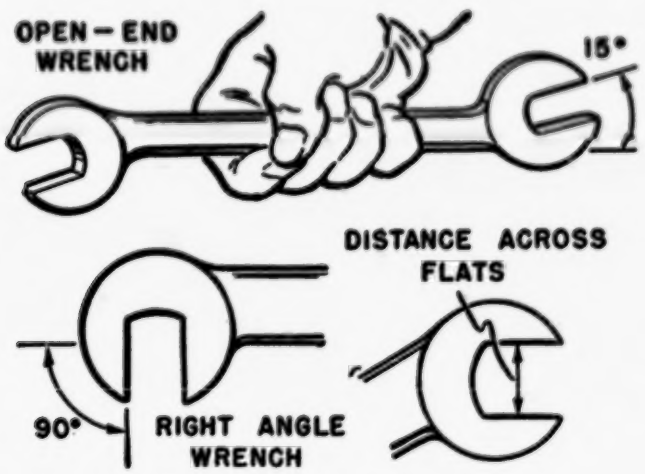
Claw Hammer

The claw hammer is used by carpenters to drive nails. It has a slight crown on the striking face. The handle can be made of wood or steel. The claw on the hammer has a narrow V for pulling nails. The hammer is sometimes called a ripping hammer when the claws are straight.

Ball Peen Hammer

Here is a drawing of the ball peen hammer. This is a mechanic's hammer, used to work with metal or around machinery. Weights vary from 2 to 48 ounces, with 16 as about standard.

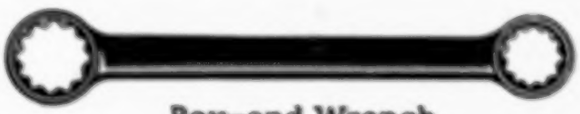
Most hammering is done with the flat face. The peen is the round end of the hammer. The ball peen's specialty is riveting, which is started with the ball end and finished with the face.



Open-end Wrenches

Open-end wrenches are shown in this drawing. These are used to turn nuts and bolts. They come in many different sizes. The jaws may be at different angles to the handle. Handles are usually straight.

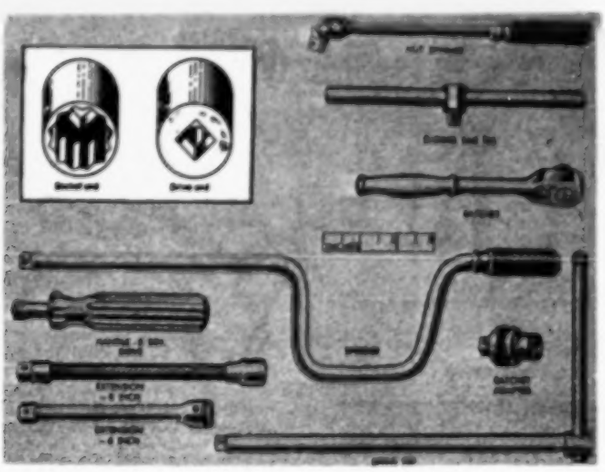
Curved-handle wrenches are called S wrenches. Some handles are offset. They make it easy to reach bolts and nuts that are below the surface.



Box-end Wrench

This is a box-end wrench. Its strength is determined by the number of points in its head. It may have 6, 8, 12, or 16 points. The 6-point and 8-point wrenches are the strongest. The 16-point is used for light work. The 12-point is the most common.

The thin sides of the box-end wrench help it fit into places too small for the open-end wrench. The box-end wrench must be lifted off after each pull. Unless it can be turned completely, it is better to use the open-end wrench to finish a job.



Socket Wrenches

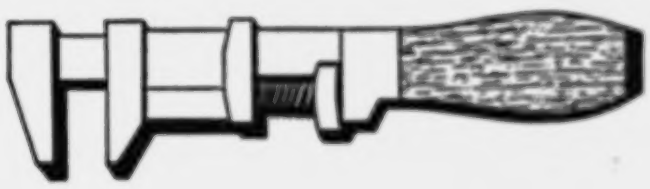
These are socket wrenches. Socket wrenches come in sets. A set includes several sockets and several handles. These can be put together to make the best wrench for a particular job.

When a straight wrench cannot be used, a universal joint is added. The universal joint is placed between the handle and the socket. This joint allows the handle to be used at an angle to the socket.

Extra deep sockets are used to remove or replace spark plugs. They are helpful when nuts are a long way down the bolt.

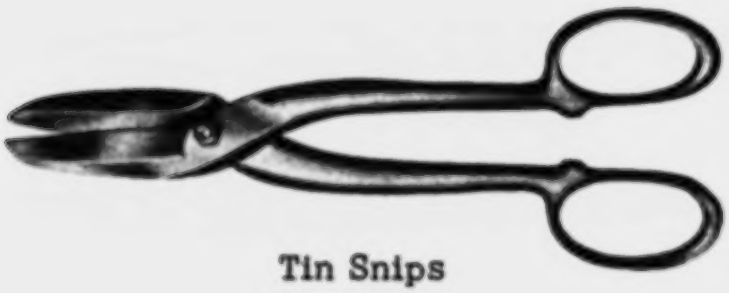
Pipe Wrench

This picture shows an adjustable pipe wrench. It is used when rotating round objects such as pipes. One jaw of the pipe wrench is movable. This tool must be used with care because its jaws have teeth and can mark the object. An adjustable pipe wrench is often called a Stillson wrench.



Monkey Wrench

Do you recognize the wrench in this drawing? It is the old-fashioned monkey wrench. It works well on large square nuts, but is too bulky for small jobs. The jaws can be adjusted. Jaws on some monkey wrenches are adjusted by turning the handle. On others, like the one shown here, a nut is used to adjust the jaws.



Tin Snips

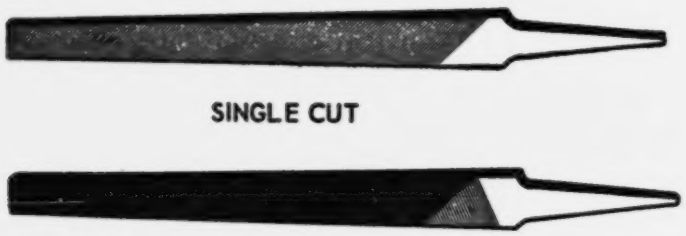
The "scissors" you see in this drawing are really hand snips or tin snips. They are used to cut light sheet metal up to 1/16 inch thick. They can also cut slightly heavier soft materials

Care must be taken when cutting heavier metals. Only the rear part of the blades should be used. If the snips are used incorrectly, the blades can be sprung, and then the snips cannot be used.

Hacksaws

The two tools in the drawing are hacksaws. They cut metal that is too heavy for snips to cut. Hacksaws can cut bolts and metal bars. A hacksaw has two parts—the frame and the blade. The frame may be adjustable or solid.

The adjustable frame holds blades from 8 to 16 inches long. The blades are steel. Those that are hardened all over are called all-hard blades, and those with only the teeth hardened are called flexible blades.

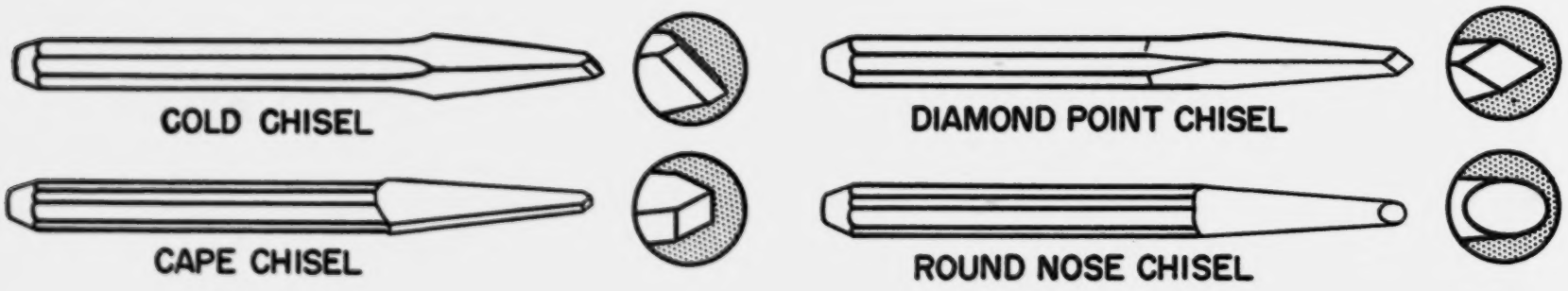


Files

Here are a single-cut and a double-cut file. Can you see the difference? The single-cut file's teeth are in parallel rows. The double-cut file's teeth are in crisscrossed rows.

The single file is used to sharpen tools, smooth metal edges, and for finish and drawfiling.

The double-cut file is fast-cutting. It is used to remove metal quickly and for rough work.



Cold Chisels

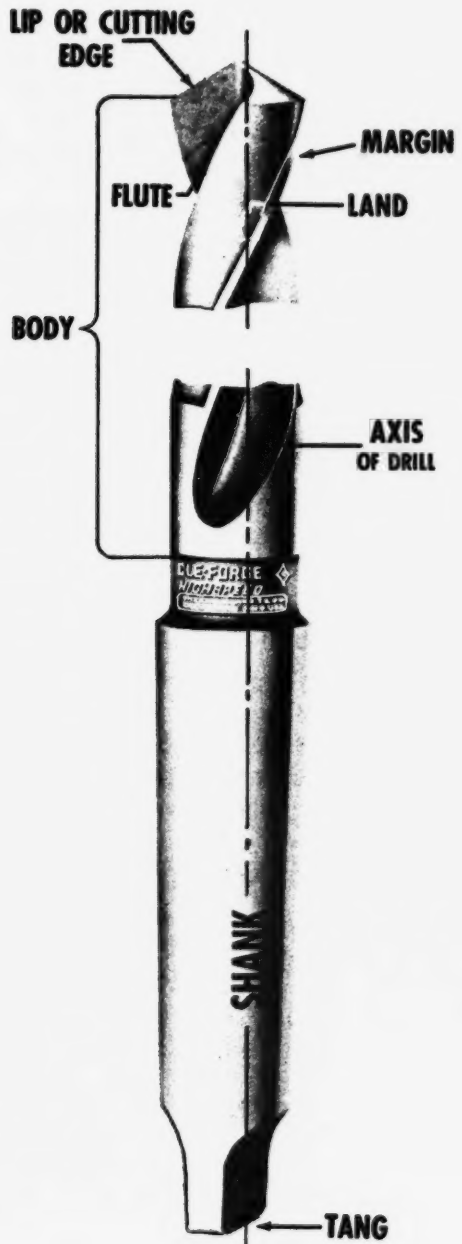
These are types of metal-working chisels. They are used to cut or chip metal or masonry. The chisel can cut any material that is softer than the chisel.

Cold chisels are usually made of hardened alloy steel and are grouped according to the shape of their points. They are often used to cut rivets, split nuts, and cut thin metal sheets. The flat cold chisel is the most commonly used.

The round nose chisel cuts semicircular grooves and chips rounded inside corners.

The diamond point chisel is used to cut sharp corners and V-shape grooves.

The cape chisel is used to cut keyways, grooves, slots, and square corners.

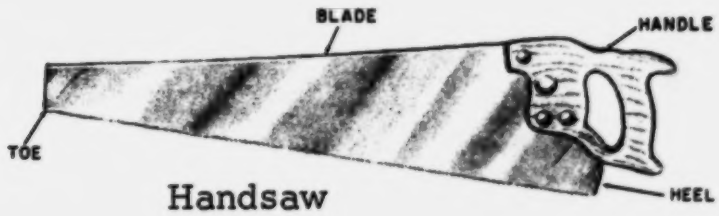


Twist Drill

This drawing shows the parts of the twist drill. This is the most common tool for making holes in metal. The cutting edge or

lip is the part that actually cuts away the metal when a hole is drilled. It is usually as sharp as a knife.

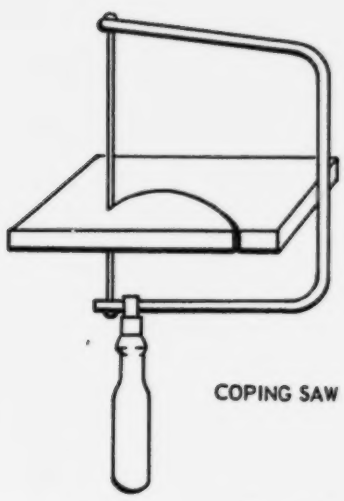
The tang is a part on tapered-shank drills only. It fits into a slot in the spindle of a machine. Its main use is to make it easy to remove the drill from the machine.

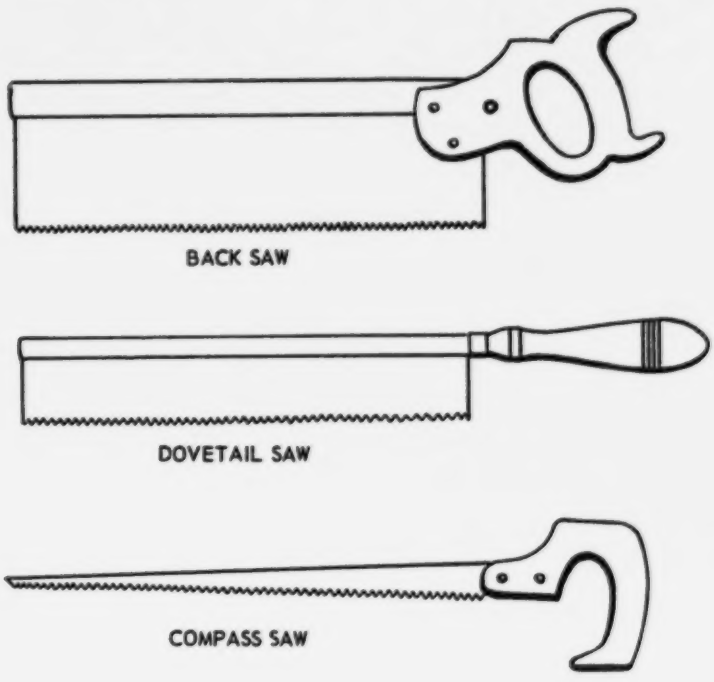


Handsaw

Most of you will know what this drawing is. It is a handsaw. It is one of the most common carpenter's tools. It is a woodcutting tool.

What a saw is used for depends on the number of teeth per inch, and the shape and size of the teeth.





Special Saws

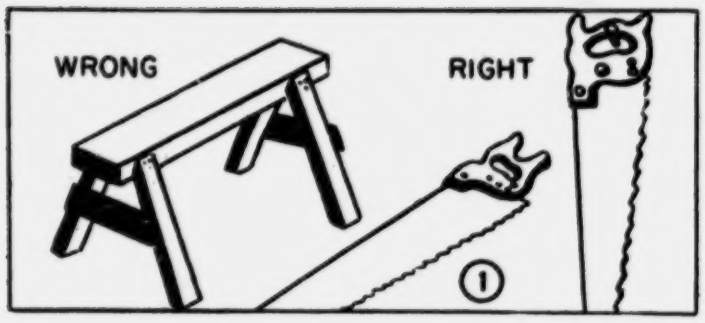
The backsaw is used to cut a straight line across a piece of wood. It is a crosscut saw. The heavy steel frame at the top keeps the blade perfectly straight.

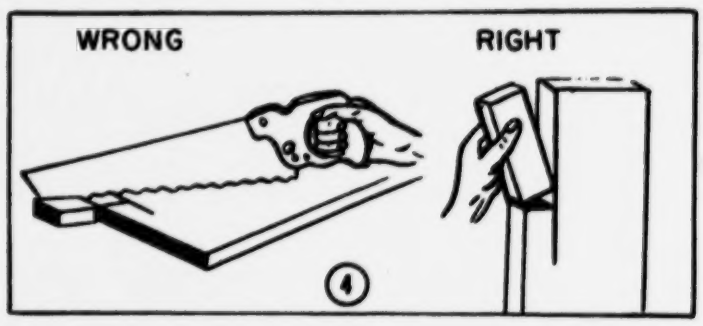
The dovetail saw has a thin, narrow blade. It is a special type of backsaw. Notice how its handle is different.

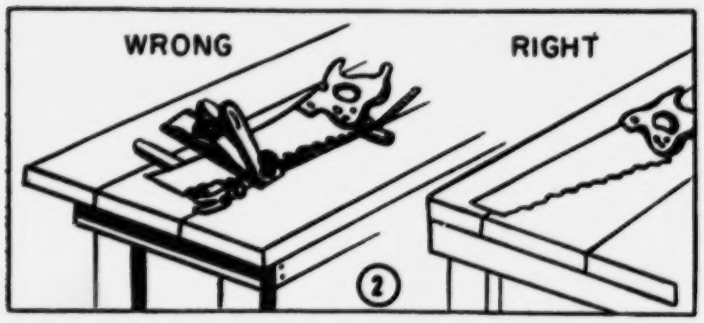
The compass saw is used to cut out circles or other odd shapes. Sometimes it is called a keyhole saw when it is finer and narrower.

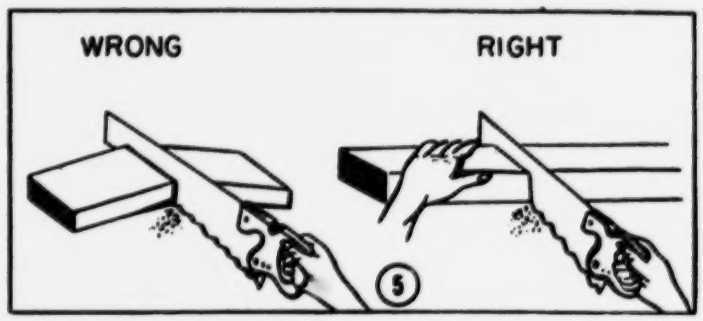
The coping saw is used to cut along curved lines.

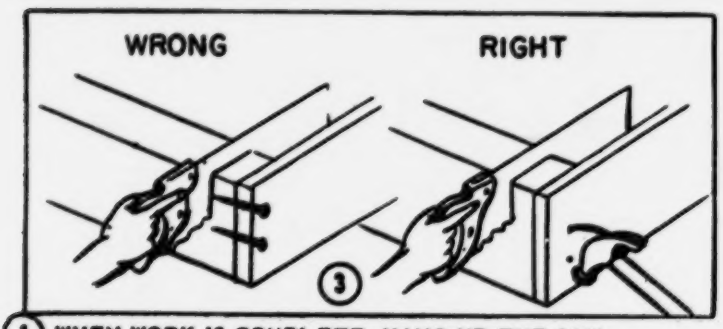
Care of Handsaws

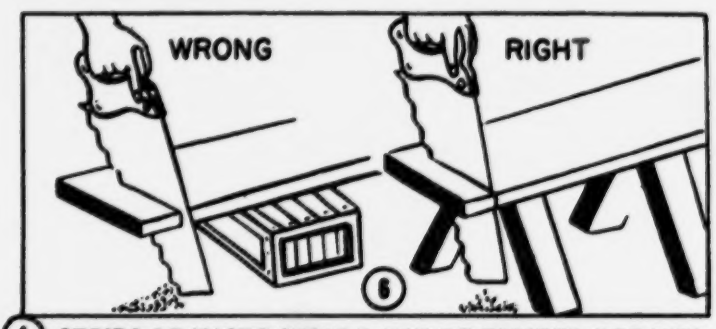




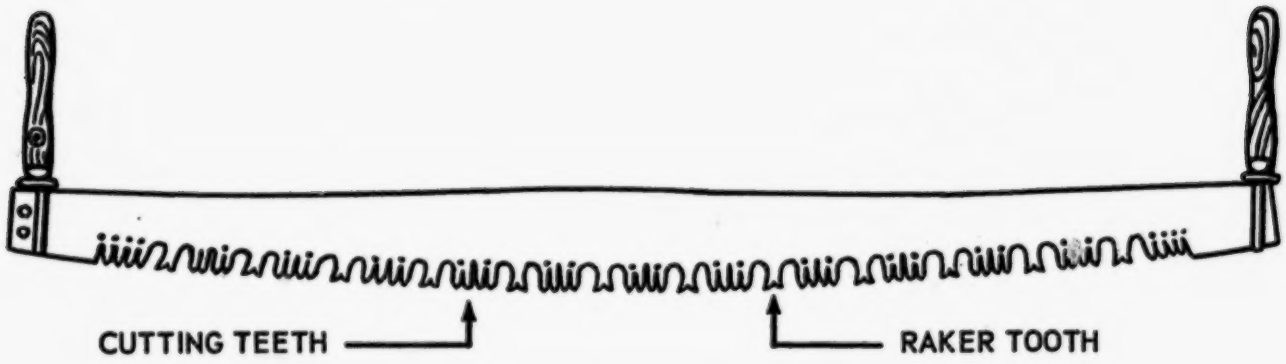








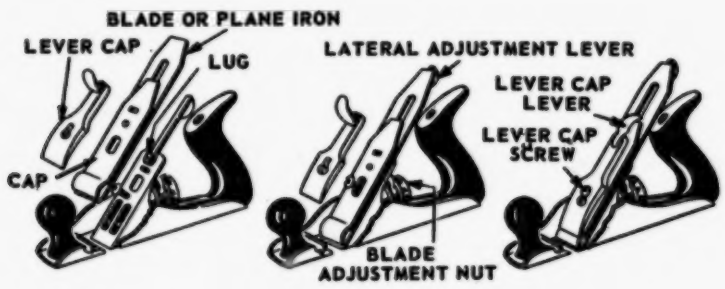
1. WHEN WORK IS COMPLETE, HANG UP THE SAW.
2. DO NOT PILE TOOLS ON TOP OF THE BENCH SO AS TO DISTORT BLADE.
3. LOOK CAREFULLY OVER REPAIR OR ALTERATION WORK; SEE THAT ALL NAILS ARE REMOVED TO AVOID CUTTING INTO METAL.
4. STRIPS OF WASTE SHOULD NOT BE TWISTED OFF WITH BLADE, BUT BROKEN OFF WITH HAND OR MALLET.
5. SUPPORTING THE WASTE SIDE OF WORK WILL PREVENT SPLITTING OFF.
6. RAISE THE WORK TO A HEIGHT SUFFICIENT TO KEEP THE BLADE FROM STRIKING THE FLOOR. IF THE WORK CANNOT BE RAISED, LIMIT THE STROKE.



Crosscut Saw

Notice the way the teeth on this saw are spaced. This is a two-man crosscut saw. To use the saw, one man pulls it as far as it will come to him. Then the other man pulls it back.

Its teeth are grouped in sections. The cutting teeth do the actual cutting, and the raker teeth remove chips of wood. This saw is used to cut down trees and to cut them into logs or heavy bridge timbers.



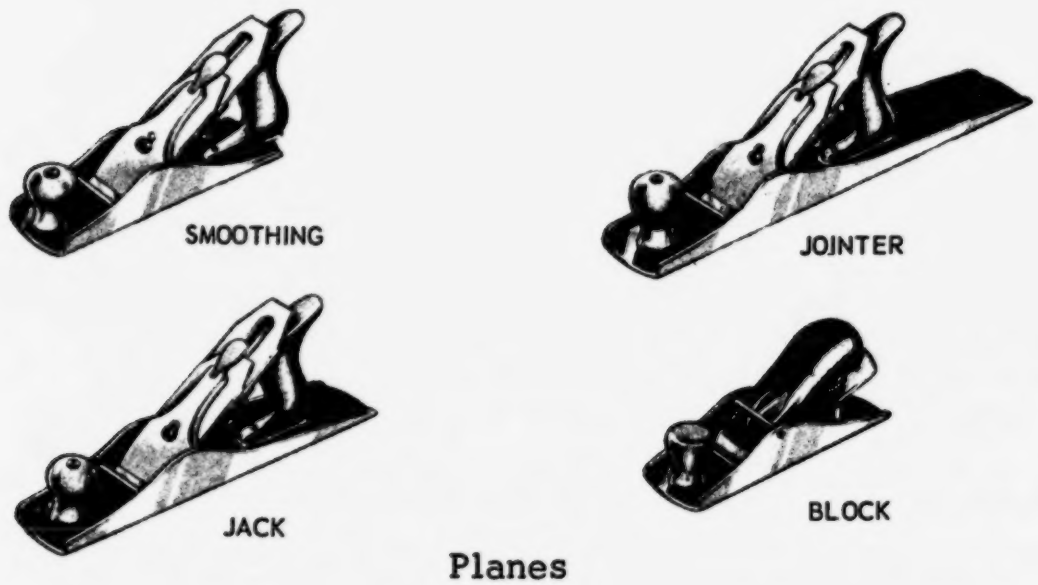
Bench Plane

This picture shows the principal parts of the bench plane, and the way in which they are assembled.

A plane is a hand tool used to shave wood. It is widely used.

Bench planes and block planes are used for general surface smoothing and squaring. Other planes are used for special types of surface work.

The plane has an iron cap that is screwed to the upper face of the blade. When the plane is pushed forward, the cap keeps shavings from clogging the plane's mouth.



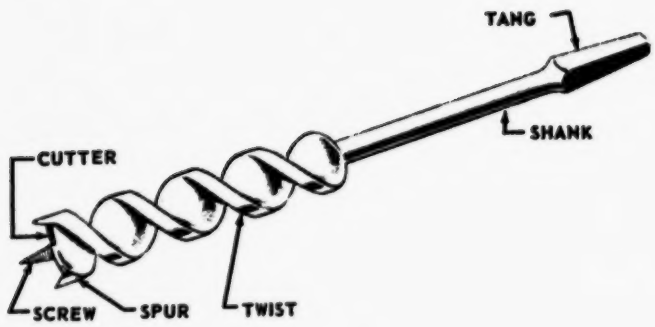
Planes

Here are some types of bench planes and a block plane.

There are three types of bench planes: the smoothing plane, the jack plane, and the jointer plane. The main difference among them is the length of their soles. The sole of a plane is the underneath surface that touches the wood. The smoothing plane has a 9-inch sole. The jack plane has a 14-inch sole. The jointer plane's sole is from 20 to 24 inches long.

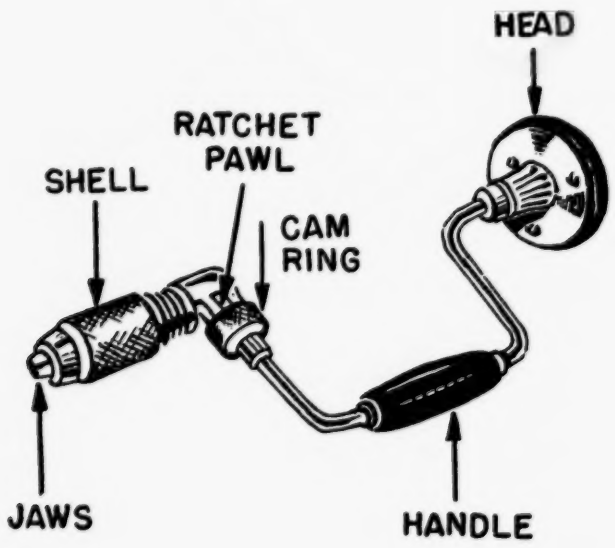
The longer the sole, the flatter the planed surface will be.

The smoothing plane makes a smooth surface in a short time. This surface may not be very flat. The smoothing plane is also used for cross-grain smoothing. The jack plane makes a truer surface than the smoothing plane. The jointer plane makes the truest surface.



Auger Bit

This is an auger bit. Its parts are labeled. Bits are used for boring holes in wood for screws, hardware, and dowels, and for many other purposes. Auger bits come in many sizes. The regular auger bits are from 7 to 9 inches long. Shorter auger bits, about 3-1/2 inches long, are called dowel bits. Auger bits bore holes up to 1 inch in diameter.



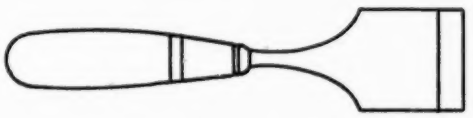
Bit Brace

A bit brace is used to hold the auger bit for turning it when boring in wood. The jaws open to grip the bit. The rachet pawl allows the bit to operate in a small space as the handle does not need to be turned all the way around.

SOCKET FIRMER CHISEL

MORTISING CHISEL

TANG PARING CHISEL



BUTT CHISEL

Wood Chisels

Wood chisels may be grouped according to types. The drawings show the shapes of some common wood chisels.

The firmer chisel is used for both heavy and light work.

The paring chisel has a thin blade and is beveled along the side. It is used for fine paring work.

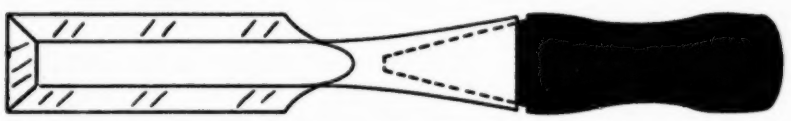
The mortising chisel is extra thick. It is used to chisel out deep, narrow mortises for mortise-and-tenon joints.

The butt chisel is made for work in hard-to-reach places.

TANG CHISEL

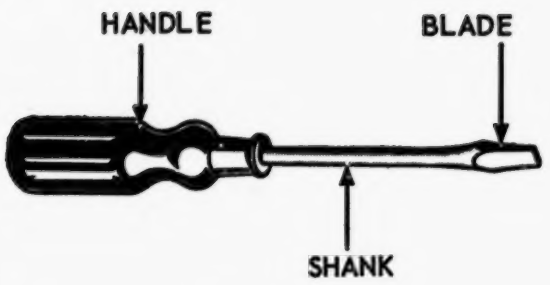
THE SHANK OF THE CHISEL HAS A POINT THAT IS STUCK INTO THE HANDLE. THE POINT IS CALLED A TANG AND THE CHISEL IS CALLED A TANG CHISEL.

SOCKET CHISEL



IF THE SHANK OF THE CHISEL IS MADE LIKE A CUP, THE HANDLE WILL FIT INTO IT. THIS IS CALLED A SOCKET CHISEL.

There are two ways to attach a chisel to a handle. These are shown here. The end of the tang chisel fits into a hole in the handle. With a socket chisel the handle fits into a hole in the metal part of the chisel.

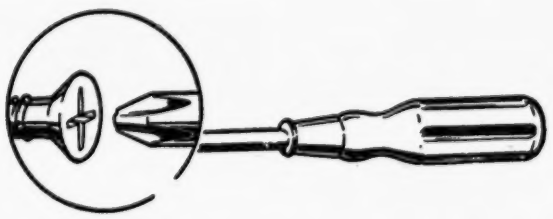


Screwdriver

The drawing points out the three main parts of a screwdriver. They are the blade, the shank and the handle.

Screwdrivers are classified by size. They usually range from 2-1/2" to 12" long. A 10-inch screwdriver is 10 inches long from end to end. There are many that are larger or smaller for special uses.

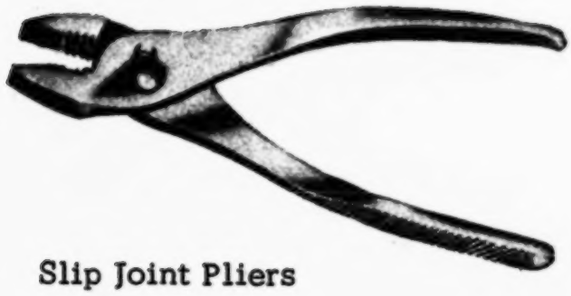
Some screwdrivers are made with a square shank for heavy work. They may be gripped with a wrench. Only this specially made screwdriver should be used with a wrench.



Phillips-head Screwdriver

This is a Phillips-head screwdriver.

It is used with a screw which has a four-way slot in its head. Notice how the screwdriver fits into the screw head. It will not slip. Its ability to hold keeps the slots and object around the screwdriver from being damaged. A regular screwdriver should not be used on a Phillips-head screw.



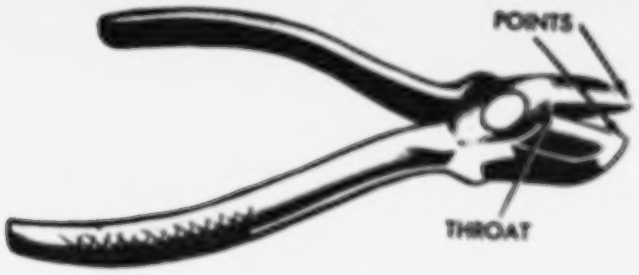
Slip Joint Pliers

Pliers are one of the most commonly used hand tools. There are pliers made for many special uses. One manufacturer makes 125 different standard types and sizes. But most of the work is done with five different types.

The most commonly used pliers are the combination slip joint pliers. They are used to hold and grip all kinds of work from a pipe to delicate pieces. The slot in one side of the pliers allows the jaws to be adjusted to two positions. Sometimes slip joint pliers have cutters inside the jaws for cutting wire or small nails.

Utility Pliers

This is a pair of utility pliers. The jaws can be set to a series of openings. Sometimes they are called water pump pliers. Their parallel jaws make them ideal for gripping such things as bonnets on sink faucets, garden hose couplings, or spark plugs. Their long handles make them easy to use on plumbing jobs.



Diagonal-cutting Pliers

These pliers are called diagonal-cutting pliers. Sometimes they are called "diagonals." They are used for cutting small, light-weight material such as wire and cotter pins. They are designed for cutting only. They should never be used to hold large objects.

Side-cutter Pliers

Side-cutting pliers, or side-cutters, are used for holding, bending, and cutting thin materials or small size wire. The jaws are hollowed out on one side just forward of the pivot point. Opposite the hollowed out portion are the cutting edges. Side-cutters are often called electrician's or lineman's pliers. Pictures A and B show two steps in stripping insulation from a wire.

Here are some commonly used punches. They are usually held in the hand and hit on one end with a hammer. The punch ends are shaped for special jobs, as their names indicate.

Center Punch

A center punch is used to mark the center of a hole that is to be drilled in metal. This mark or dent will keep the drill from slipping. The center punch is also used to mark pieces for reassembly.

Starting Punch

Starting punches are made to withstand heavy blows. Their main use is in dissassembling machinery where there is a tight fit. Also, they are used to knock out rivets after the heads have been chiseled off.

Pin Punch

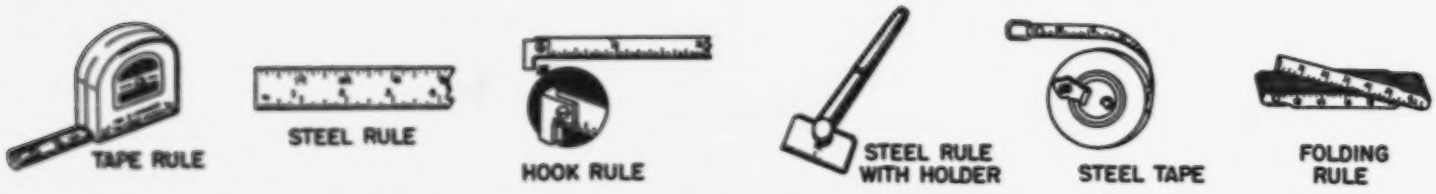
The pin punch is used to complete the job of freeing pins when other punches are too large. This is also called a drift pin.

Aligning Punch

The aligning punch is used for assembling parts of a machine. It is used to line up holes for parts that go together.

Hollow Shank Gasket Punch

The hollow shank gasket punch is used to make holes in leather, cork, rubber, or composition materials. The end of the gasket punch is round and hollow and cuts a round hole when hammered down on the gasket material. The cut out material goes up the hollow shank and leaves a neat clean hole.

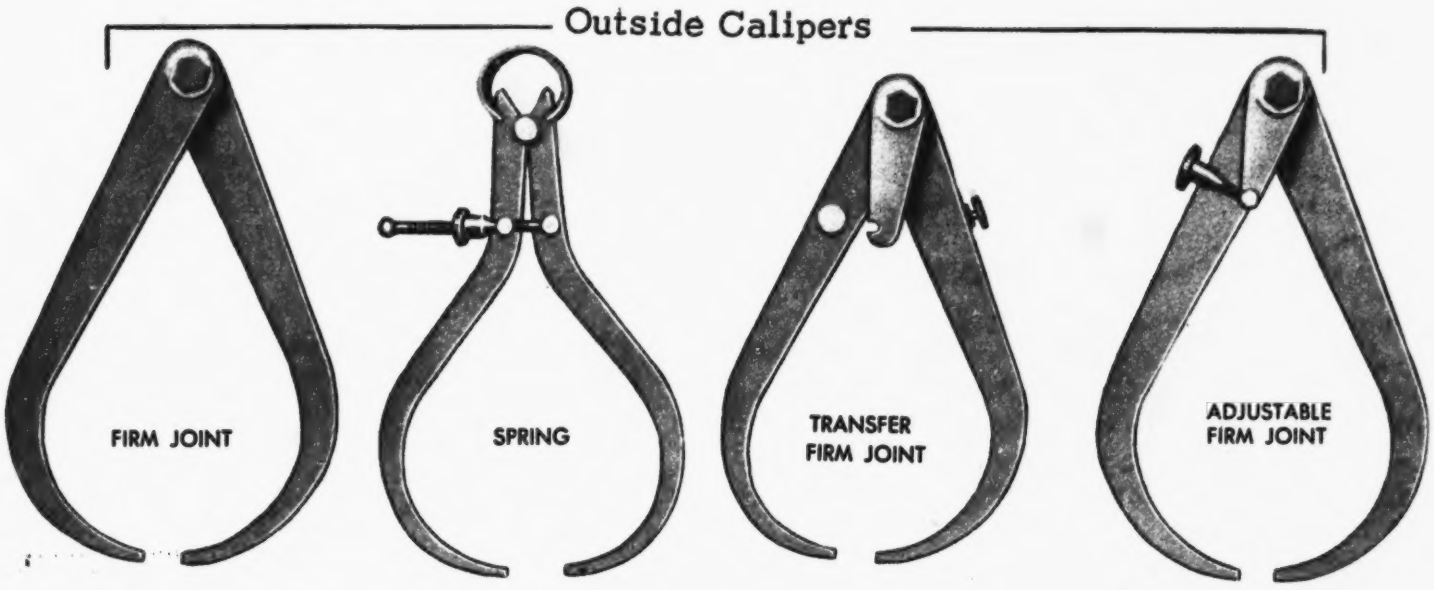


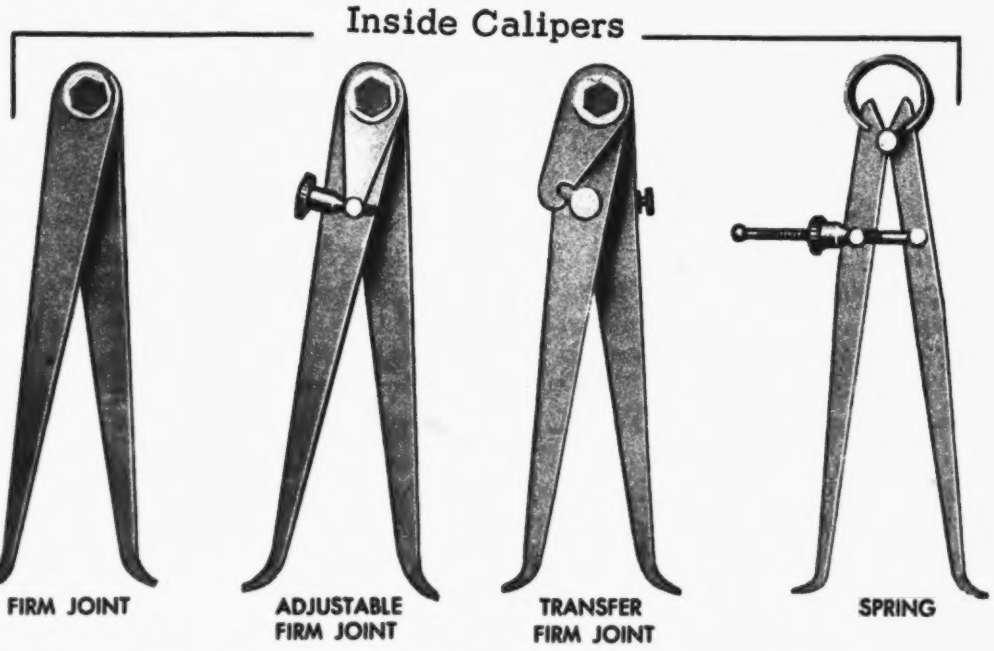
Tapes and Rules

Here are some common types of tapes and rules. The steel rule is the most common and the simplest. It is easiest to measure accurately with a thin steel rule because the division marks are nearer the work.

Usually the rule has markings on each edge of each side. Inches may be divided into eight equal spaces on one edge and 32 or 64 equal spaces on the other. This way, parts or fractions of an inch may be measured.

For measuring lengths greater than 18 inches, folding rules or flexible tapes are used. Folding rules, sometimes called zig-zag rules, generally are from 2 to 6 feet long. Steel tapes are from 6 feet to 100 feet long.



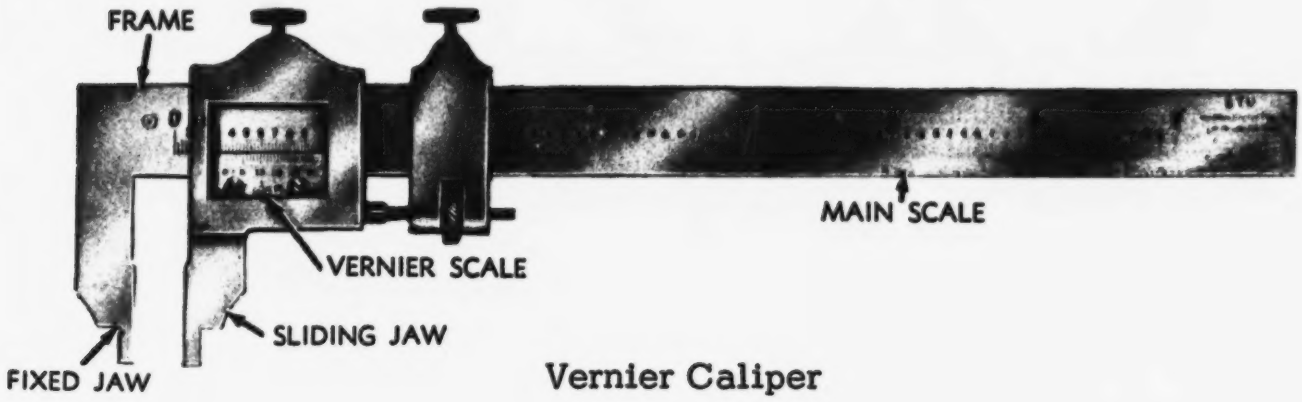


These are some simple calipers. They are used with a scale to measure diameters, cavities, and thicknesses.

As you will notice, calipers for measuring outside diameters and thicknesses have bow legs. Calipers for measuring inside diameters and cavities have straight legs with the feet turned out. Some calipers are adjusted by pushing or pulling their legs to open or close them. Some have a small screw for fine adjustments.

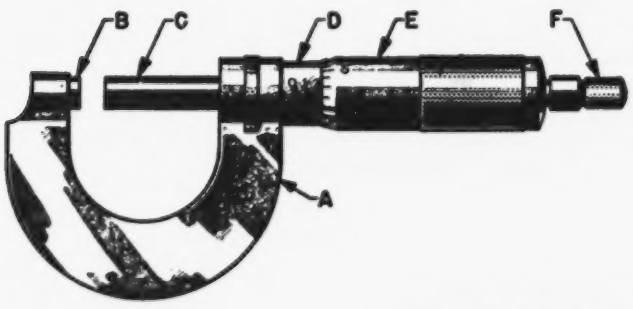
Spring joint calipers have legs joined by a strong spring hinge. Transfer calipers are used to transfer measurements from a standard

scale to the work. They differ from other calipers in that they can be opened or closed and then moved back to an exact setting.



Vernier Caliper

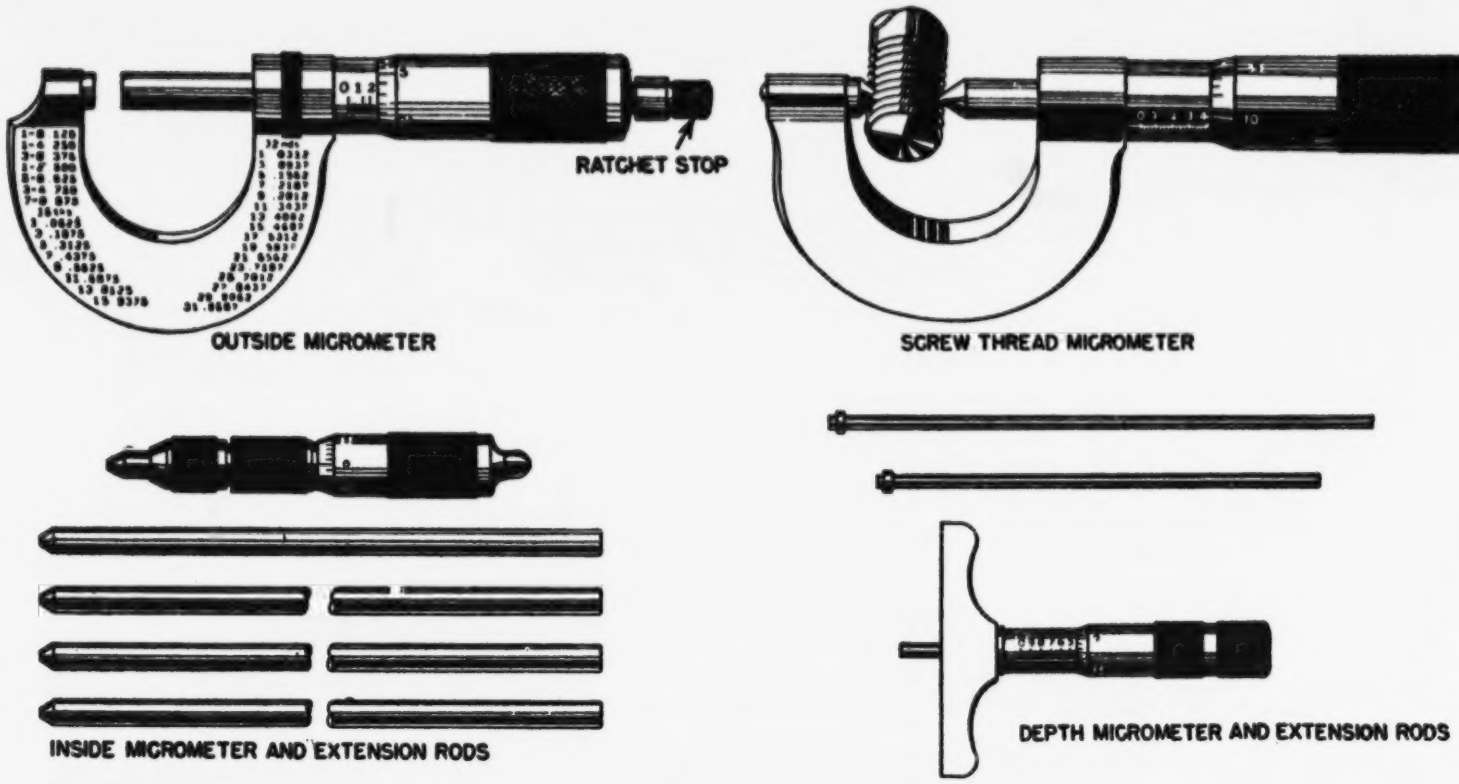
This is one kind of vernier caliper. It can give very accurate measurements over a large range. It is used for checking both inside and outside measurements. Sizes are available up to 4 feet. The sliding jaw can move up and down the main scale. The vernier scale is engraved on a small plate attached to the sliding jaw. There are many other kinds of vernier calipers for special uses.



A. Frame
B. Anvil
C. Spindle
D. Sleeve
E. Thimble
F. Ratchet stop

Micrometer Caliper

This is an outside micrometer caliper. The letters point to its main parts. It is often called a "mike." It is used to measure distances as small as one-thousandth of an inch. This measurement is written as a decimal, so you must understand decimals to use a micrometer.



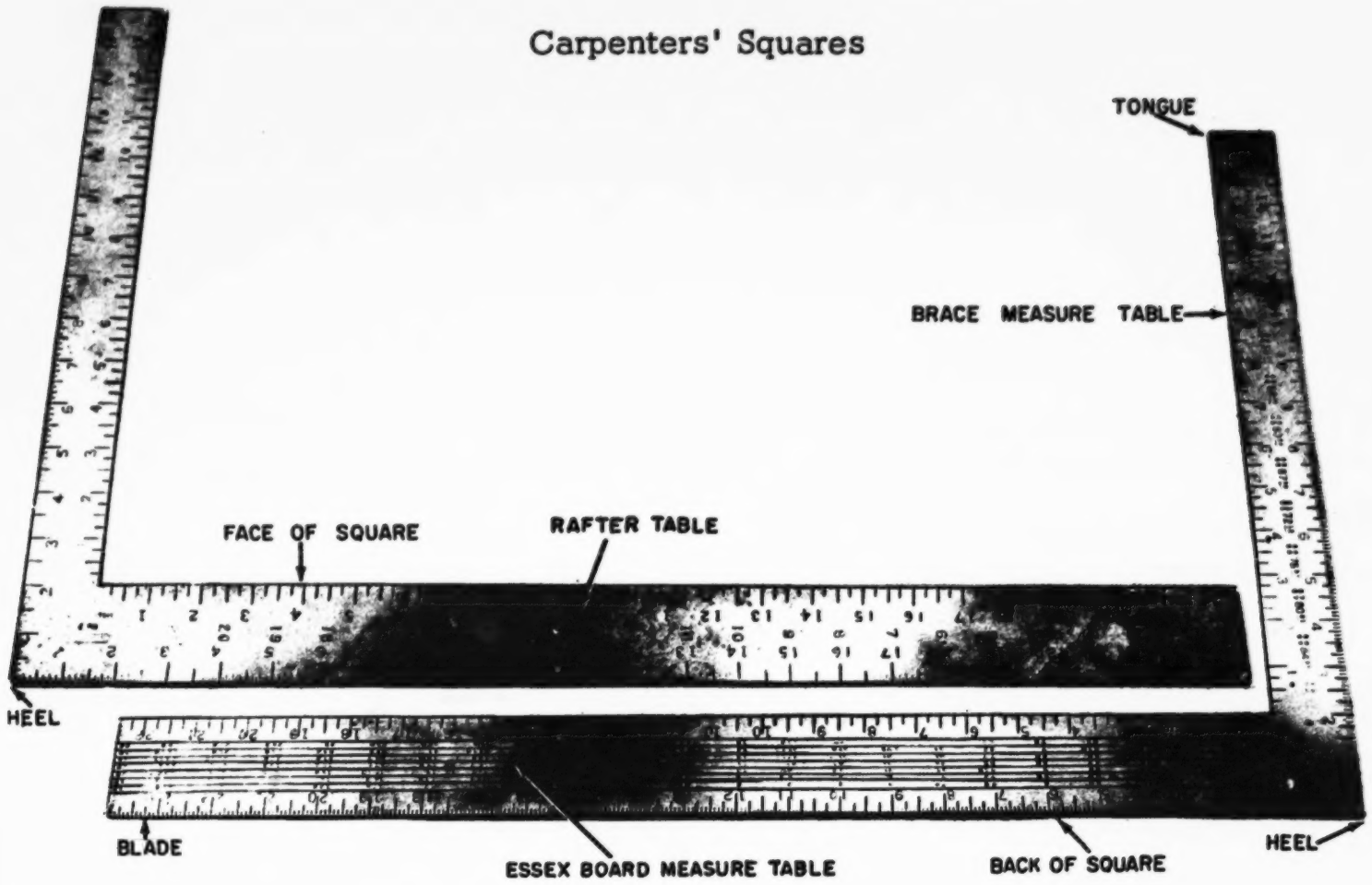
Micrometers

Here are some common types of micrometers. The outside micrometer measures outside dimensions. It may be used to measure the diameter of a steel rod, for example. The screw thread mike is designed to measure the pitch diameter of screw threads.

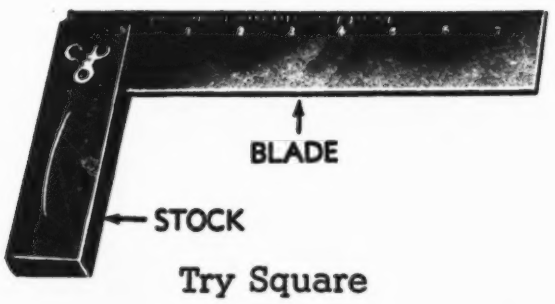
The inside micrometer measures inside dimensions. It may measure the inside of a hole, for example. The dimensions it measures are between the two ends of the instrument. The extension rods are necessary to make it fit holes of different sizes.

The depth micrometer measures the depth of holes or recesses.

Carpenters' Squares

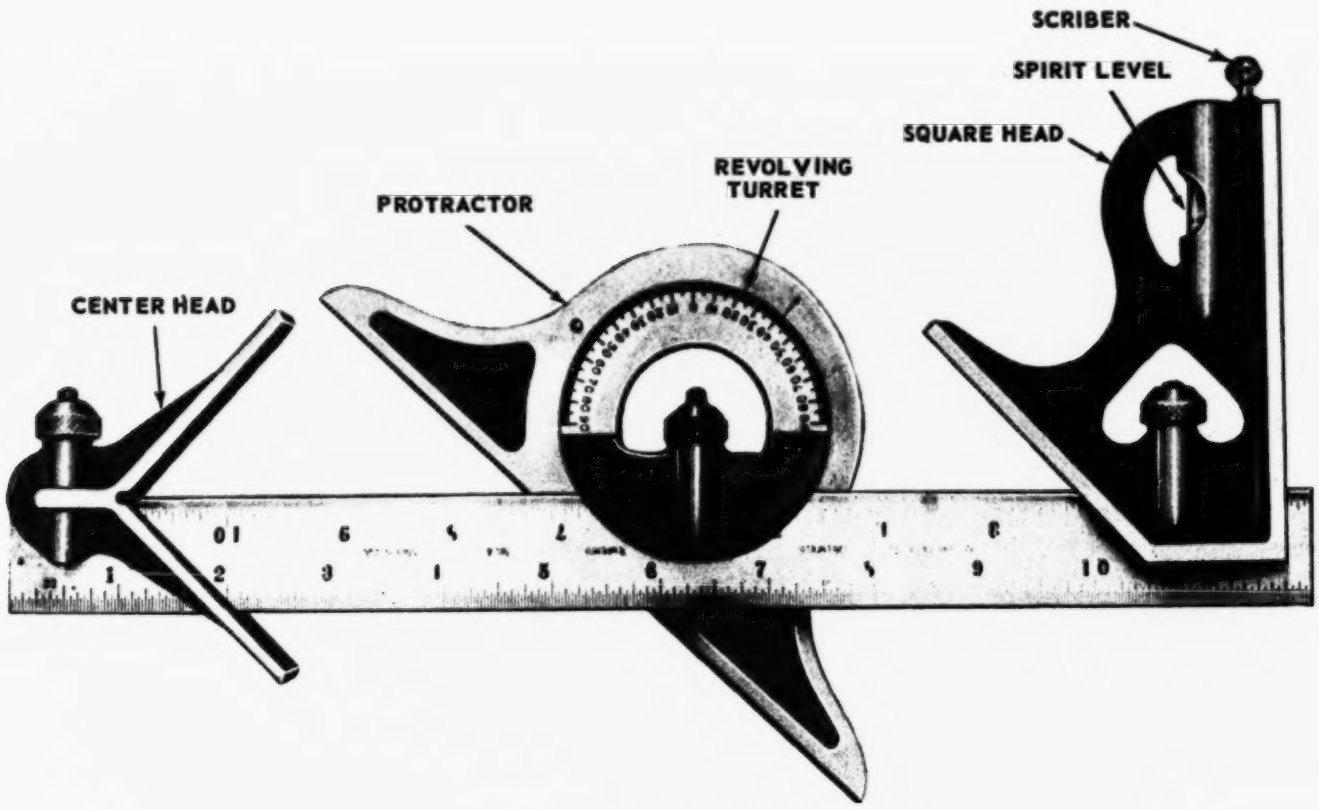


These are carpenters' steel squares. The carpenter uses them to cut material squarely and to test the squareness of things before he nails them. They help the carpenter lay out guidelines for cutting rafters, stairs, oblique joints, and other objects. He also uses the square to see if things are flat.



Try Square

This is a common try square. Its blade is from 2 to 12 inches long. It is used to draw or check lines or surfaces that must be at right angles to each other. It is more accurate for this use than the larger carpenter's square.



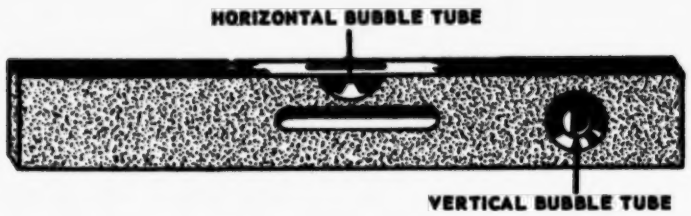
Combination Square Set

This drawing shows a combination square set. The three heads are used one at a time. It is a layout tool, and can be used in many ways.

The square head can be adjusted along the scale, or can be removed entirely. It can be used as a level, try square, mitre square, plumb, depth gauge, and scribing gauge all in one. The small scriber is used for making layout lines. The spirit level is used to check whether surfaces are plumb or level.

The center head is used in place of the stock head to locate the exact center of round stock.

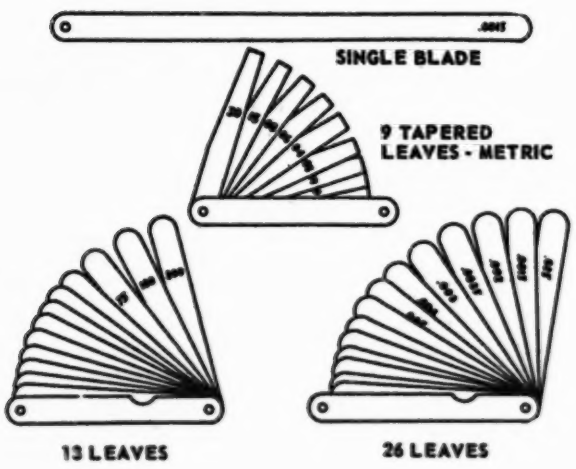
The protractor head is often called a bevel protractor. It can be adjusted to any position on the scale and locked at any angle.



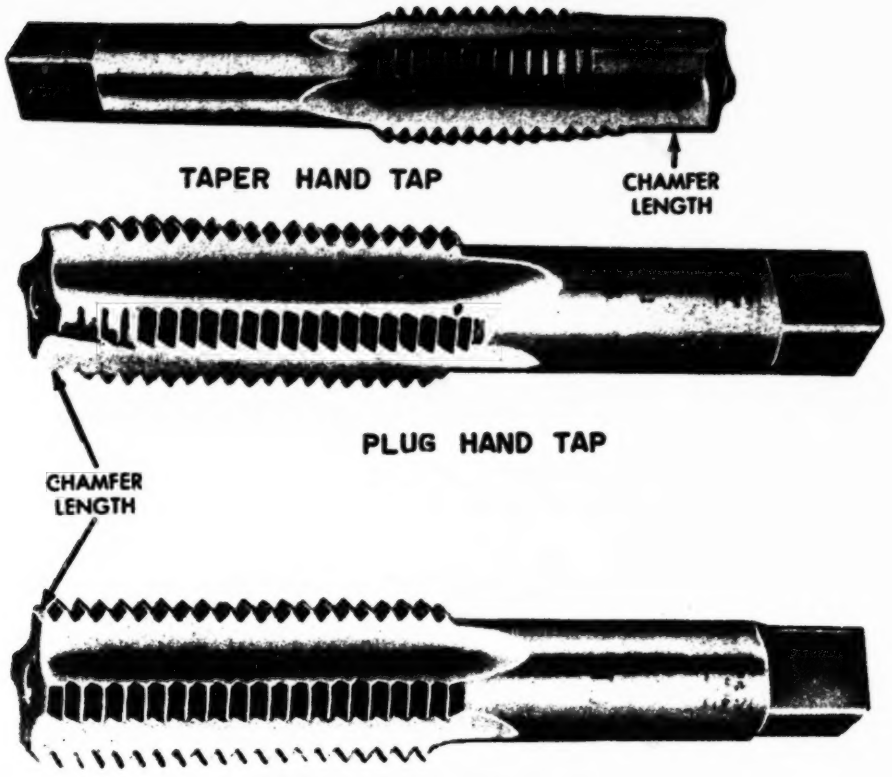
Carpenter's Level

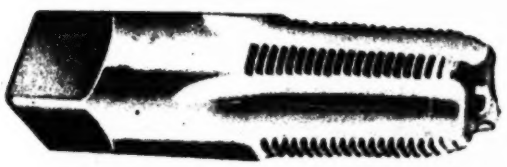
A carpenter's level is usually made of wood or aluminum and is about two feet long. It is used to find the true horizontal or vertical by means of the bubble in the sealed tubes. A shorter model of the carpenter's level is called a torpedo level, which may be equipped with magnets to free the hands when working with pipe or sheet metal.

Feeler Gauges



Thickness or feeler gauges are used for measuring the space between two surfaces. They are often made in leaf form to allow checking and measuring of small openings. Most blades are straight, but some are bent at the end. The leaves fold back into the handle when not in use.





TAPER PIPE TAP

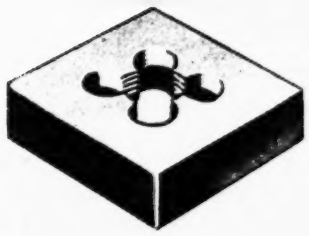
Taps

Taps are used to cut inside threads in metal, hard rubber, or plastics. The taps shown here are the most common of many types.

When cutting threads in a hole drilled into a piece of metal, a set of three taps is used. The taper tap makes the first cut. Then the plug tap completes the thread nearly to the bottom of the hole. Then the bottoming tap is used to finish it.

Pipe taps are used for pipe fittings and in other places where tight fits are needed. All the threads on pipe taps cut. On the taps above, only the non-chamfered part does the cutting.

Rethreading Die

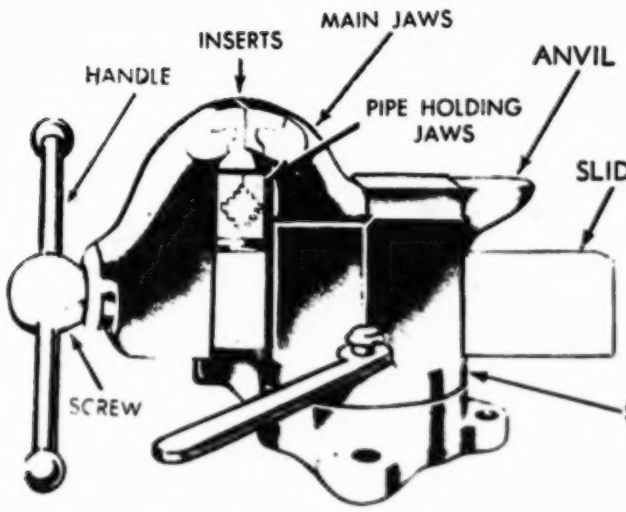


Square Pipe Die

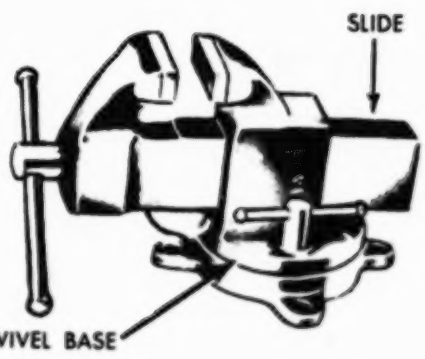
Dies

Here are two types of solid dies. Dies are used to cut outside threads on metal, hard rubber, or plastics. Solid dies are used to cut threads on pipe up to 3 inches in diameter. The square pipe die is for cutting American Standard Pipe Thread only.

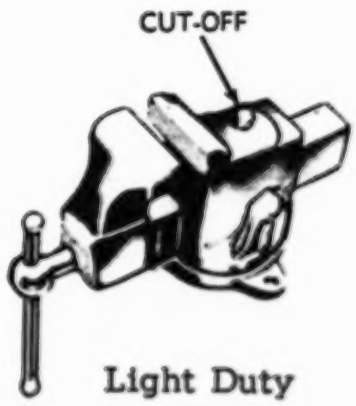
The rethreading die is used for dressing over bruised or rusty threads on bolts, screws, or pipe.



Bench and Pipe Vise



Machinist's Bench Vise



Light Duty Vise

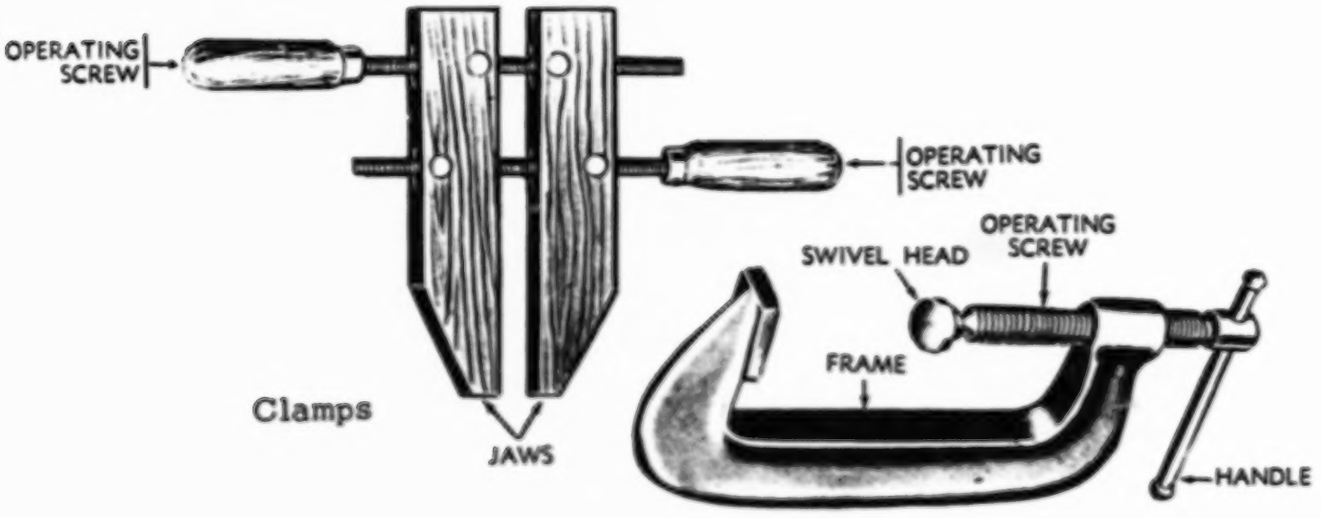
Bench Vises

These are common types of bench vises found in machine shops and carpenter shops. Vises hold work that is being planed, sawed, drilled, sharpened, shaped, riveted, etc., at the bench. When holding work in a vise, blocks of wood are used to protect the finish of the work from the holding grooves in the jaws of the vise.

They are often equipped with an anvil. They are also bolted to the workbench. The machinist's bench vise is a large steel tool. Some vises can be rotated on the bench. That is the purpose of the swivel base.

Clamp Base Bench Vise

Clamp base vises usually do not have pipe-holding jaws. They have a smaller holding capacity than the machinist's or bench pipe vises.

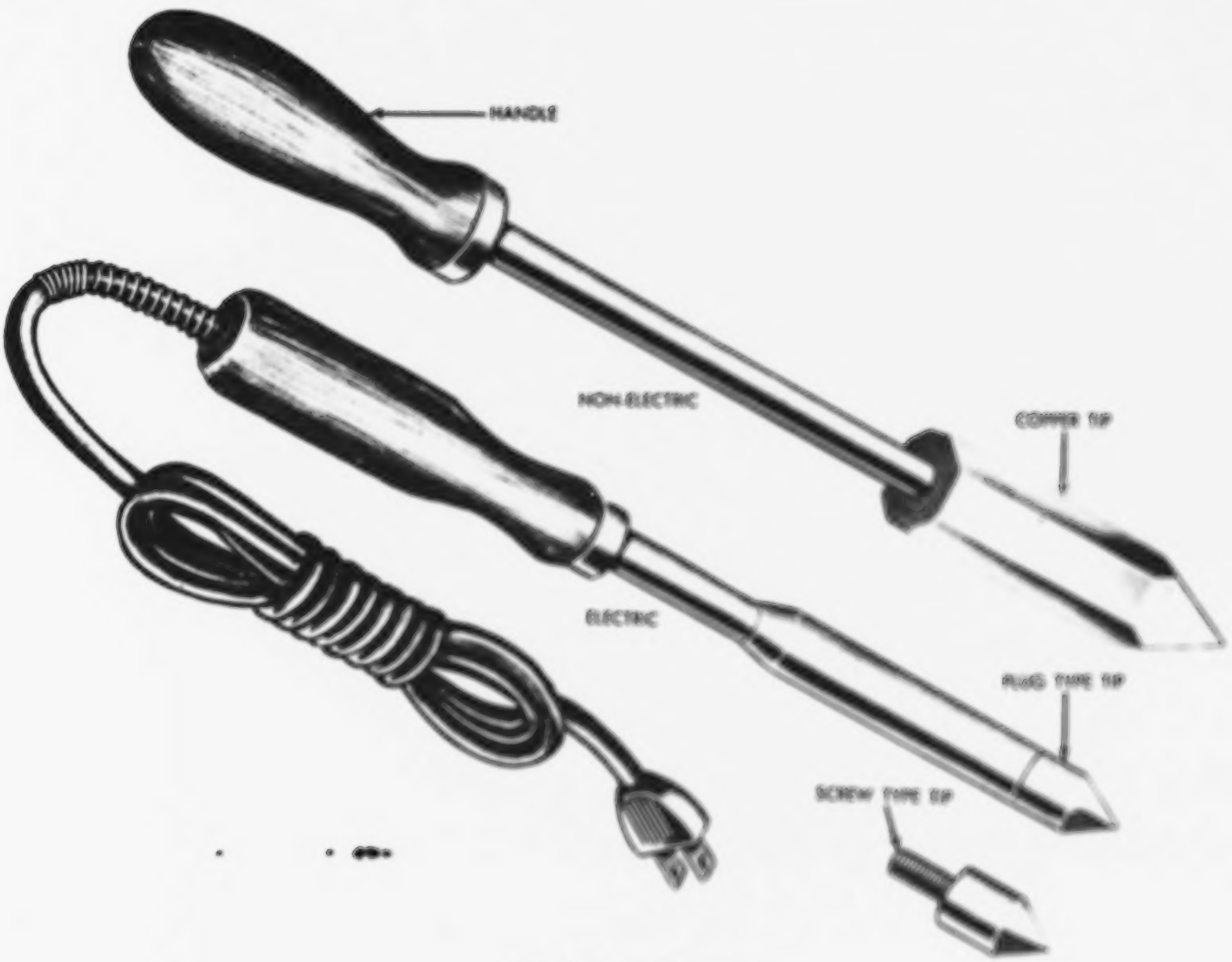


Clamps

This drawing shows a hand screw clamp and a C clamp. Clamps are used for light work, and come in a variety of sizes.

The hand screw clamp has two metal inserts in each wooden jaw. The operating screws are threaded into these inserts.

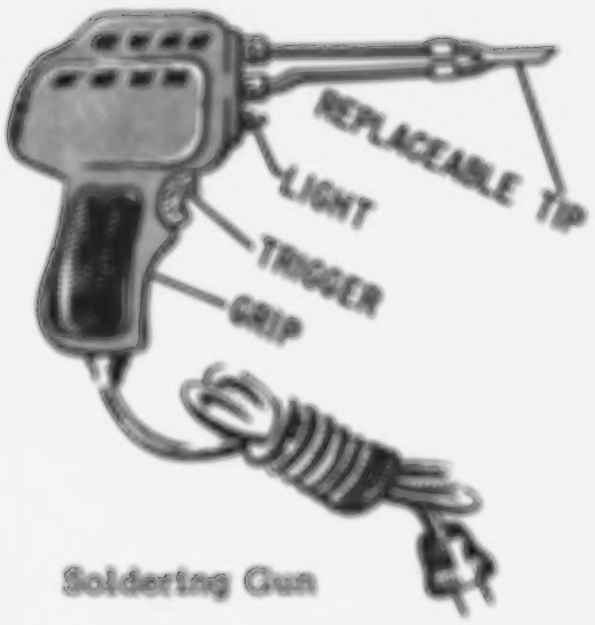
The C clamp looks like the letter C. The operating screw has a swivel head. C clamps are used for light, medium, and heavy service.



Soldering Irons

Here are two soldering irons. One is electric, the other is not. Soldering means joining two pieces of metal by means of solder that is applied in the molten state. The soldering iron melts the solder. It also heats the metal parts to the right temperature for joining or repairing. The tip of the soldering iron is heated by a self-contained coil of resistance wire. This wire is called the heating element. Electric soldering irons are grouped according to the number of watts they use.

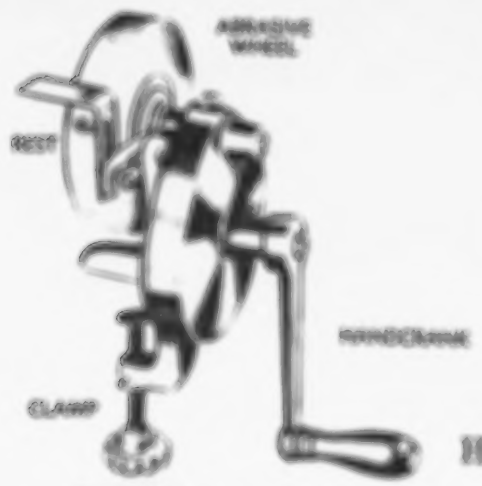
Non-electric soldering irons are sized by weight. They must be heated over a flame or with a blowtorch.



Soldering Gun

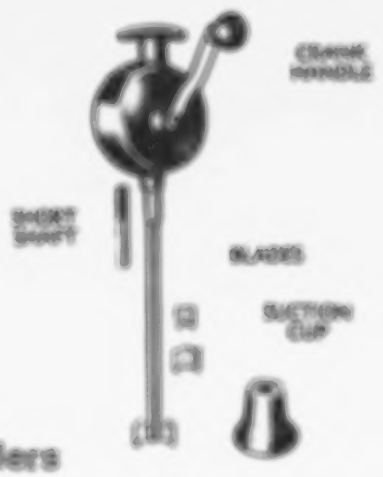
Here is a picture of an electric soldering gun. It is an induction-type soldering iron. These guns are rated by the number of watts they use.

Electric soldering guns have a stepdown transformer in their bodies. The transformer secondary output current flows through the tip. This causes the tip to heat rapidly. It heats only when the trigger is pressed. The tip on these guns is so small they can be used in cramped places.



Bench Grinder

Hand Grinders

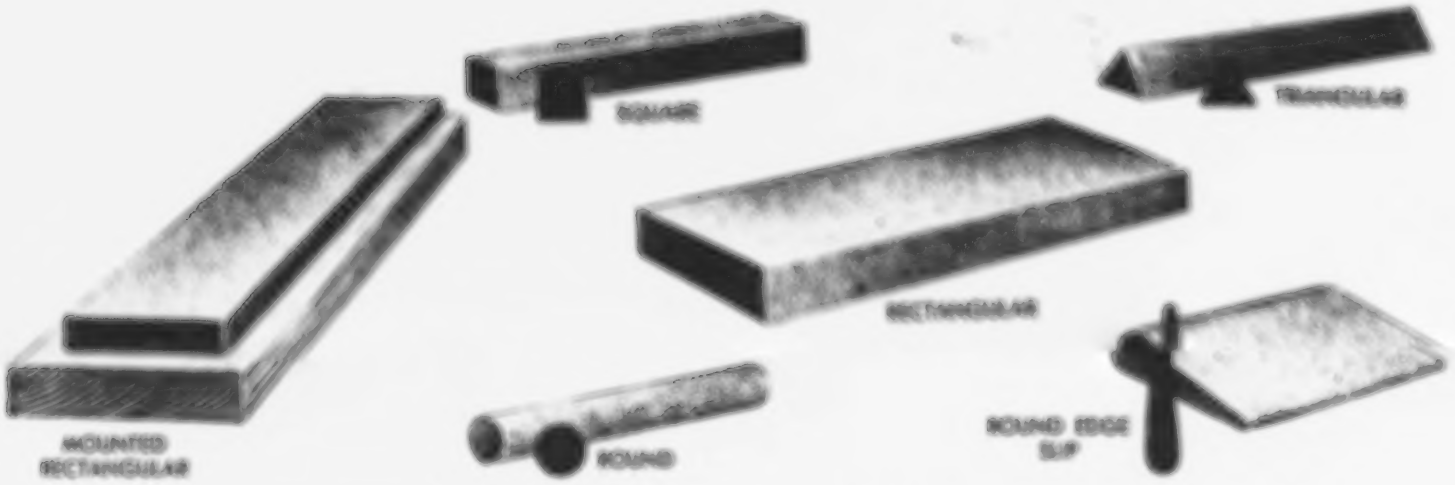


Valve Grinder

Here are two types of hand grinders. They are the bench grinder and the valve grinder.

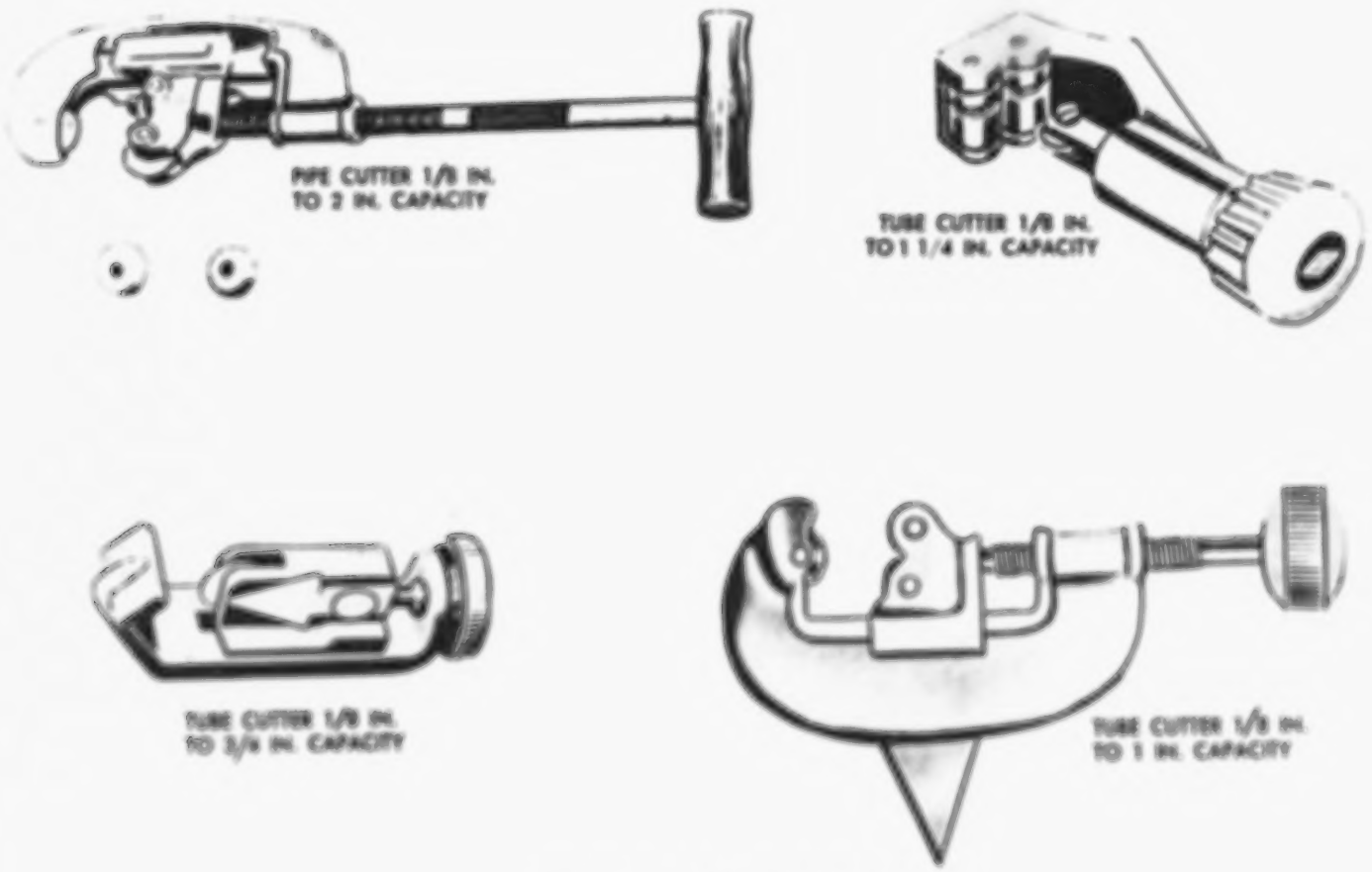
The hand bench grinder has a mounted abrasive wheel with a handcrank to turn the wheel. The wheel turns faster than the crank because of gears. The grinder clamps onto the bench. It has a rest for lining up the work when grinding.

The hand valve grinder is used to fit engine valves to their seats. The crank handle drives the gears. The gears rotate a shaft in an oscillating (back and forth) motion with the blades or the suction cup attached.



Sharpening Stones and Oilstones

Here are sharpening stones and oilstones of various shapes. There are two groups of sharpening stones—natural and artificial. Some natural stones are oil treated and are called oilstones. Natural stones have fine grains. They are used to put razor-like edges on fine cutting tools. Sharpening stones usually have one coarse and one fine face.


PIPE CUTTER 1/8 IN.
TO 2 IN. CAPACITY
TUBE CUTTER 1/8 IN.
TO 1 1/4 IN. CAPACITY
TUBE CUTTER 1/8 IN.
TO 3/4 IN. CAPACITY
TUBE CUTTER 1/8 IN.
TO 1 IN. CAPACITY

Pipe and Tube Cutters

The top left-hand picture is a pipe cutter. The others are tube cutters. Tube cutters look like pipe cutters, but are lighter in weight.

Pipe cutters cut pipe made of steel, brass, copper, lead, and wrought iron. Tube cutters cut tubing made of iron, steel, brass, copper, and aluminum. Tubing has much thinner walls than piping does.

The pipe cutter has a special cutting wheel and two pressure rollers. The rollers are adjusted and tightened by the handle as the cutting is done.

Axes

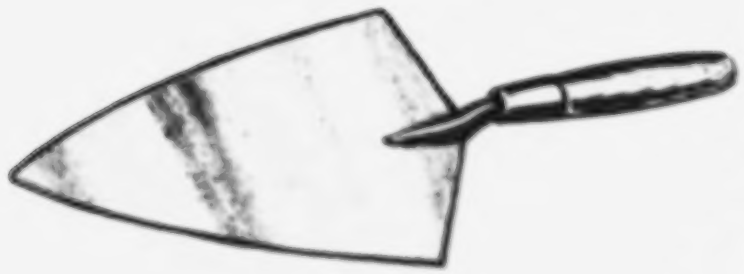
An ax is used to cut down trees, to cut logs and brush, and to split and cut wood. Axes are used by firemen to break into buildings during a fire.

Adz

This is called an adz.

Notice its curved blade and curved handle. The curved handle gives balance. It also helps give the right angle for cutting.

The adz is used to cut, shape, and smooth logs and timbers when a lot of wood has to be removed.



Brick Trowel

This is a brick trowel. Its steel blade is used to scoop and spread mortar. Its blade is also used to chip and cut bricks. The end of the handle is used for tapping bricks into place. The edge of the trowel is used to chip hardened pieces of mortar or other material from the surface of the bricks.

Cement Trowel

This is a cement trowel. It is about 4 inches wide and 14 inches long. It is used for finishing concrete surfaces. The wet concrete is pushed into place and smoothed with the edge of the trowel. The trowel must always be kept wet while it is being used.

This type of trowel is also used by plasterers to smooth plaster walls.

Pick

This is a pick. It is used to dig hard earth. It loosens the soil so that a shovel can be used. The pick can also be used for a small amount of prying. A bar must be used for heavy prying. One end of the pick has a sharp point and the other a chisel-shaped point.

D-Handled Shovel

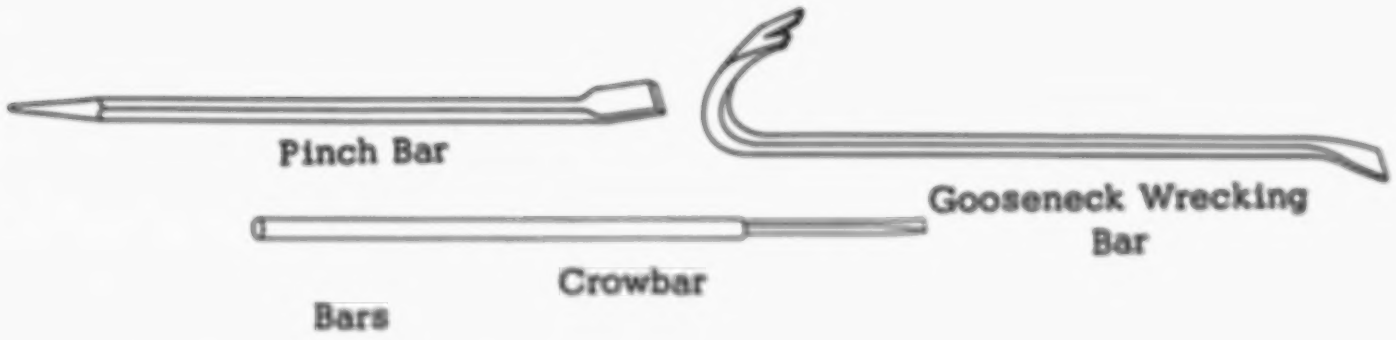
Long Handled Shovel

Shovels

These are two types of shovels. A shovel is used for moving earth or other loose material. Some shovels have pointed blades. Other shovels have round or even square cutting edges. The back of the shovel is usually square. This is so that the worker can use his foot to help push the shovel.

There are many types of shovels. The D-handled shovel, as shown in the picture, is used for light work. It is also useful when digging in cramped spaces.

The long-handled shovel is used for heavy work. It does not have a hand grip. Its handle is a pole five feet long.



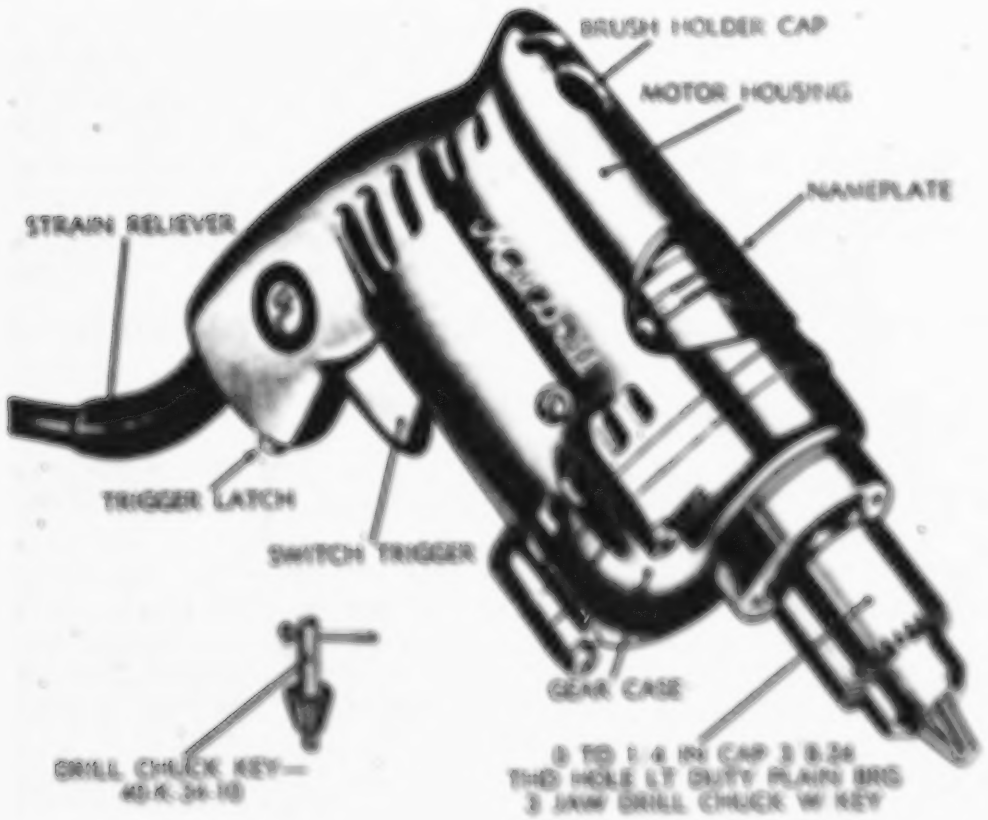
Bars

Here are three types of bars.

The wrecking bar is used to pry boards loose and to remove large nails or spikes from boards. A wrecking bar may be "goose-necked" like the one in our drawing, or straight. Both have a claw. The claw is used the same way that the claw on a claw hammer is used.

The pinch bar is used for prying open boxes and crates, loosening boards, and other prying jobs.

The crowbar is usually about five feet long. It is used as a lever to move heavy objects short distances. It can also be used to pry boulders and to break hard earth.

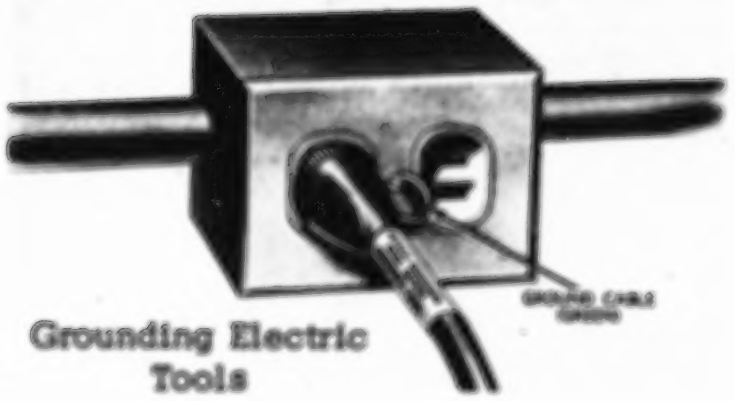


Electric Drill

This is a picture of a 1/4-inch portable electric drill. It is called 1/4-inch because that is the diameter of the largest drill its chuck will hold. The main parts of the drill are labeled.

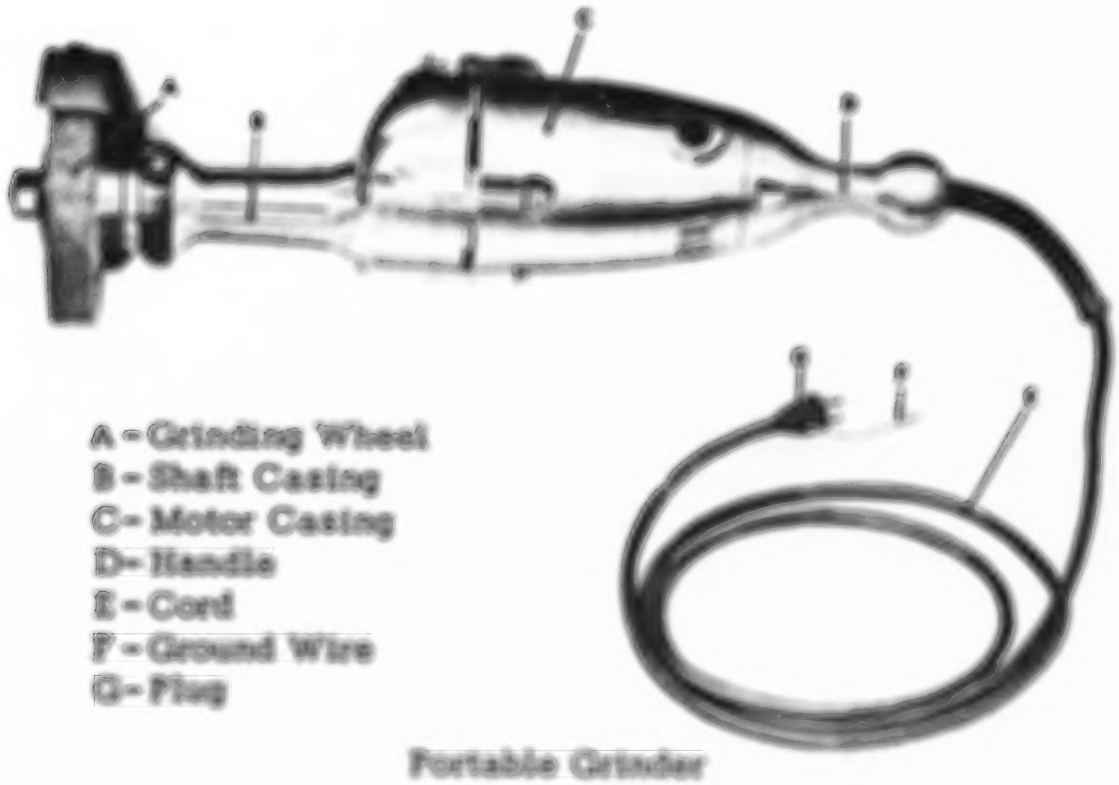
The electric drill is used to drill holes in metal and wood. There are many different types of drills and accessories that can be used for many different jobs. For example, they can be used for sanding, sawing, buffing, polishing, screwdriving, wire brushing, and paint mixing.

The switch trigger is squeezed to start the drill and released to stop it.



Grounding Electric Tools

All electric tools, such as electric drills, should be grounded. The drawing shows one way to ground a portable electric tool. The ground cable from the portable electric tool is clamped under the screw in the middle of the receptacle cover. A better way of grounding is by using a three-prong plug and outlet.



Portable Grinder

This is a portable grinder. It is a power tool, used for rough grinding and finishing of metallic surfaces. Different grain sizes and grades of abrasives can be used because the abrasive wheels are easily changed.

The grinder can use either AC or DC current. It can also use a flexible shaft attachment. This helps in grinding surfaces in hard-to-reach places.

Portable Circular Saw

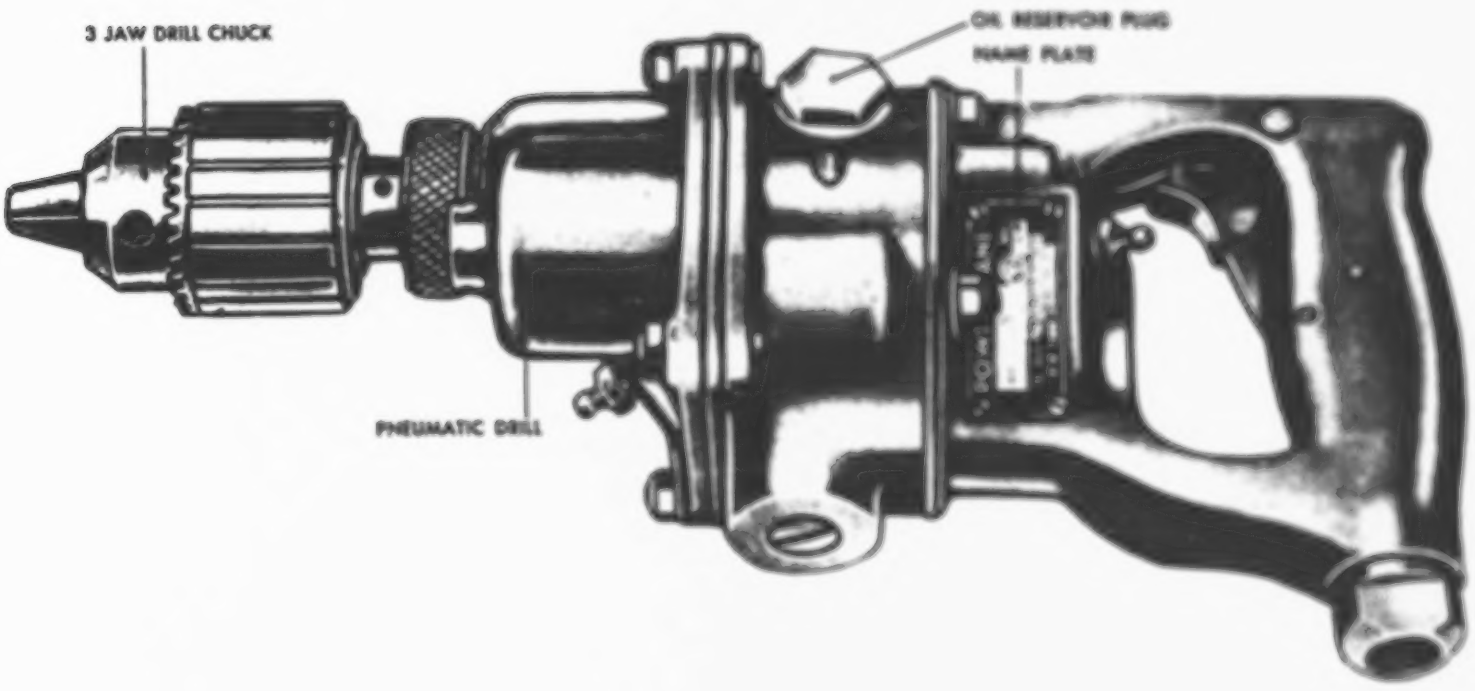
This is the portable circular saw. It is used a great deal by people who work with wood. It saves time and work, and is easier to handle than a handsaw. This saw is started by pressing a trigger. It will run only when the trigger is held.

The sizes of portable electric saws vary from a 4-inch blade to a 14-inch blade. The blades of these saws can be changed for ripping or crosscutting. Most operate on either AC or DC current.

Electric Impact Wrench

This is a reversible electric impact wrench. The main parts are labeled.

It is used for applying and removing screws, nuts, and bolts. It can also be used to drill and tap metal, plastics, wood, and other materials. It can drive and remove socket-head, Phillips-head, slotted-head, wood, self-tapping, or machine screws, by changing the socket on the anvil.



Portable Pneumatic Drill

This is a picture of a portable pneumatic drill. It is run by compressed air. It drills or enlarges holes in wood, plastics, metal, and other such materials.

The drill is operated by the trigger. When the trigger is completely depressed, it will lock in the "on" position. The button just above the trigger is pushed in to release the lock.

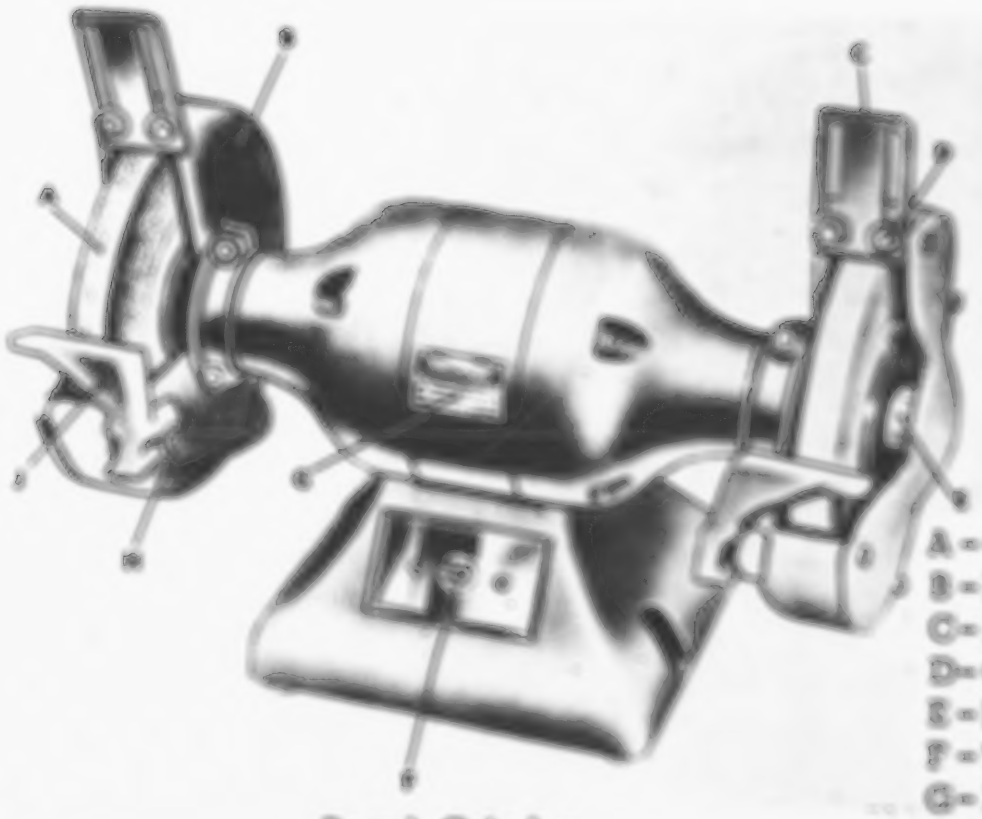
The pneumatic drill requires air pressure from 70 to 90 pounds per square inch. The air comes in through a hose attached to the handle.

Drill Press

The drill press is an electrically operated power machine, designed for work with metal. Two basic types of drill presses are the bench-type and the upright-type. The difference between them is the way they are mounted.

The picture shows a bench-type drill press. In this drill press there are four spindle speeds. Different speeds are obtained by changing the location of the V belt, seen at the top of the picture.

Small drill presses drill holes up to 1 inch in diameter. They usually have motors of from 1/3 to 3 horsepower.



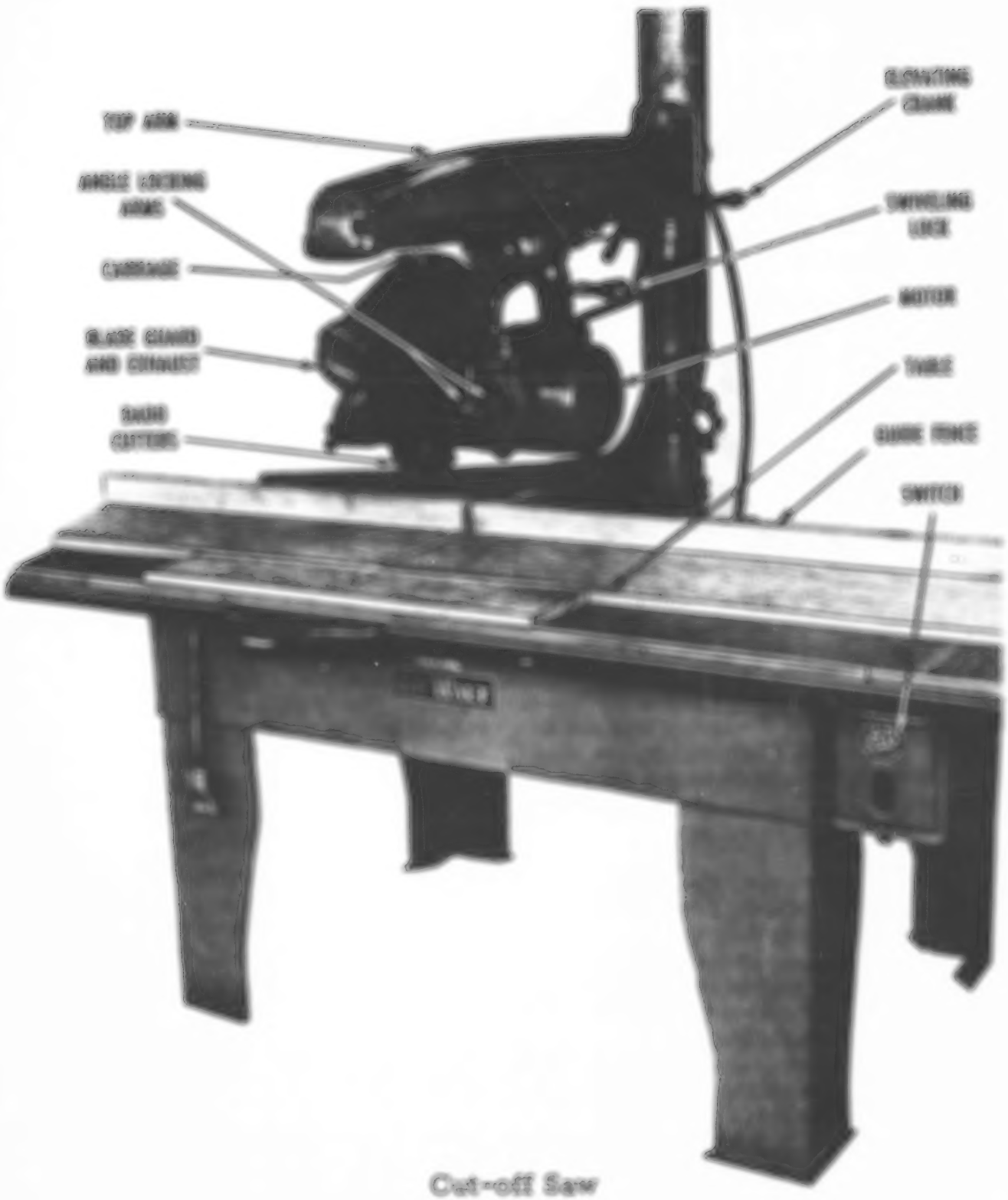
Bench Grinder

A - Grinding Abrasive Wheel
B - Left Hand Wheel Guard Assy.
C - Eye Guard
D - Cap Screw
E - Right Hand Wheel Clamp Nut
F - Toggle Switch
G - Name Plate
H - Cap Screw
I - Left Hand Tool Rest

This is an electric powered bench grinder. It is used for hand grinding jobs. It sharpens chisels and screwdrivers, grinds drills, removes excess metal, and smooths metal surfaces.

Usually it has two wheels, a medium grain abrasive wheel and a fine grain abrasive wheel. The medium grain abrasive wheel is used for rough grinding. It is used when a lot of metal has to be removed or when a smooth finish is not important. The fine grain abrasive wheel is used to sharpen tools or grind to close limits of size. The fine grain abrasive wheel removes metal more slowly, but gives the work a smoother finish.

Many bench grinders have removable wheels. They can use wire brushes, polishing wheels, and buffing wheels in place of the grinding wheels.

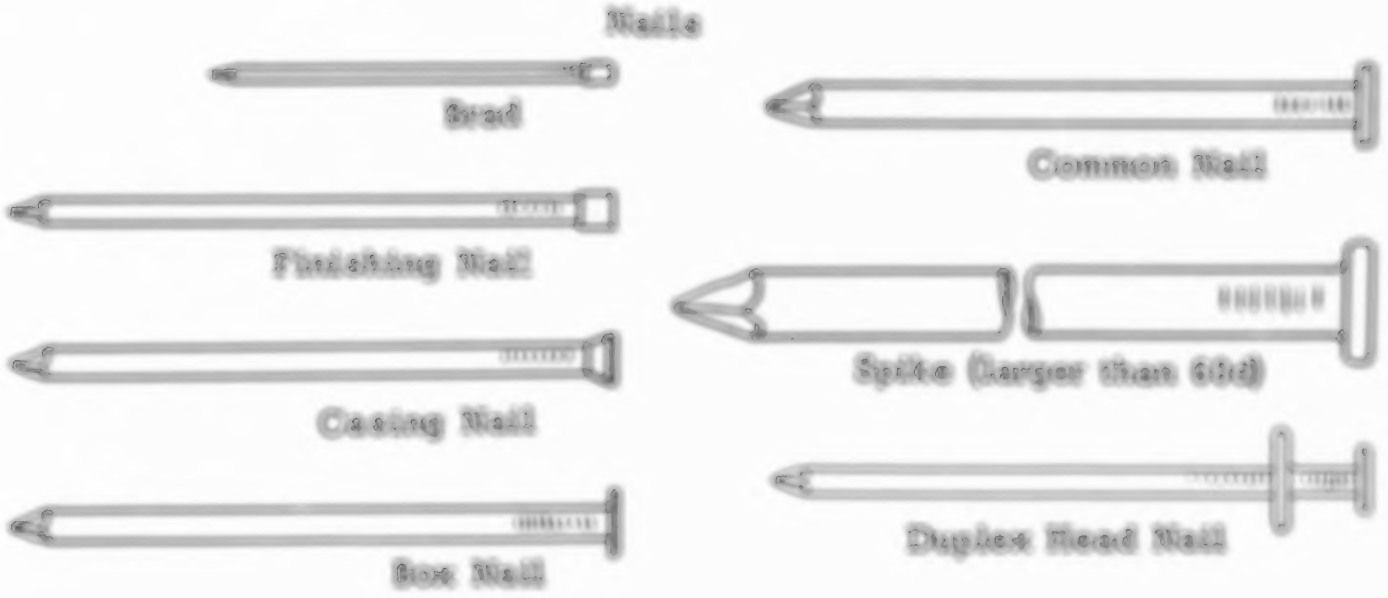


Cut-off Saw

This is a cut-off saw. It is also called a radial arm saw. It uses a circular saw to cut wood, and was designed to cut off boards squarely. It can also be used for ripping, cutting on an angle, and other wood-cutting jobs.

The motor can be turned and tilted. The arm can be adjusted up or down. This flexibility makes the machine ready to do many kinds of jobs.

FASTENING DEVICES



Here are pictures of the more common types of nails. The brad nail and the finishing nail have deep countersunk heads. They are designed to be set below the surface of the work.

The casing nail has a flat countersunk head. It can also be set below the surface. It can be driven flat with the wall.

The other nails shown are flat-headed nails. The common nail is the one which is used most in general wood construction.

Large short flat-headed nails are used to nail roofing paper, plaster board, and other thin or soft materials.

Duplex head nails are also called double-headed nails. They are used to nail temporary structures. The nail is driven to the lower head. It is pulled out by using a hammer on the upper head.

The penny system is used to show lengths of nails. The letter "d" is used as an abbreviation for "penny" just as it is with English money. A "2d" nail is a twopenny nail.

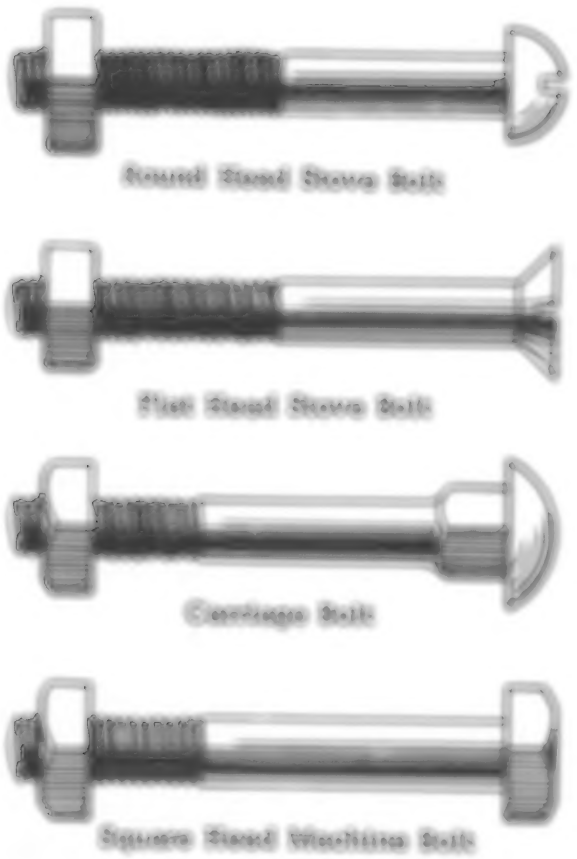
Wood Screws

Here are some common types of wood screw heads. Screws are grouped according to the type of head and the material they are made of. For example, there are screws called "flathead brass" and "roundhead steel" screws.

The ordinary screw has a slotted head. A lag screw has a square bolt-type head. Some screws have Phillips-type heads.

The size of a screw is determined by its length and body diameter. The diameter is the measurement across the center of the unthreaded part of the screw. The body diameter is shown by gauge numbers. Gauge numbers start at 0, which equals about 1/16 of an inch diameter, to 24, which equals about 3/8 of an inch diameter.

Screws range from 1/4 inch to 5 inches long. The boxes screws are sold in show the length and gauge number of the screws. For example, "1-1/4 - 9" means that the box contains screws that are 1-1/4 inches long and are number 9 gauge. A large gauge number means a large screw.



Bolts

Some common types of bolts are shown above.

Bolts do not thread into wood as screws do. Bolts go through the wood or metal and are held by a nut. The nut is threaded onto the end of the bolt.

Stove bolts range from 3/8 to 4 inches long and have diameters from 1/8 to 3/8 inch. They have either round or flat slotted heads.

Carriage bolts and machine bolts range in length from 3/4 inches to 20 inches. Their diameters range from 3/16 inch to 3/4 inch. The square section below the head of the carriage bolt is embedded in the wood. This keeps the bolt from turning as the nut is drawn up. The machine bolt is held with a wrench to prevent its turning.

Machine Screws

There are some common types of machine screws. They are small screws used in tapped holes to put together metal parts. Sometimes machine screws are used with nuts. Usually they are screwed into holes that have been tapped with matching threads.

Machine screws are usually made of steel or of brass. Sometimes they are plated. Plating prevents corrosion or rusting. Aluminum and stainless steel machine screws are also available.

To describe a machine screw requires knowing the length, thread diameter, head shape, finish, and material from which it is made. For example, "1/2 inch, 8-32 t.p.i., round head, brass, chromium-plated machine screw," describes one type of screw.

Setscrews and Thumbscrews

These are setscrews and thumbscrews. Setscrews are used for securing small pulleys, gears, and cams to shafts, and for providing positive adjustment of machine parts. They are grouped by diameter, thread, head shape, and point shape. The point shape determines the holding ability of the setscrew.

Dog point and cone point setscrews hold best.

Headless setscrews do not stick up above the surface. They are used with moving parts. These screws are threaded completely from point to head.

Common setscrews have square heads. They are used on fixed parts.

Nuts

The drawing shows some common kinds of nuts. The standard nuts are square or hexagonal. There are special nuts, too.

The jam nut is used above a standard hexagonal nut to lock or "jam" it in position.

Castellated nuts are slotted. A cotter key is pushed through the slots when they are lined up with a hole in the bolt. This prevents the nut from coming loose.

Wing nuts are used when it is necessary to make frequent adjustments by hand.

Cap nuts are used when it is necessary to have a pleasing appearance or to prevent the end of the bolt from catching on something. They are sometimes called acorn nuts.

Thumb nuts can be turned by hand. They are knurled so they can be gripped with the fingers. They are easy to use.

Electric stop nuts are used when it is very important that the nuts do not come loose. They are used on fire control and radio equipment. These nuts have a fiber or composition washer built into them. The washer is compressed automatically against the screw threads. This provides holding tension.

Flat Washer

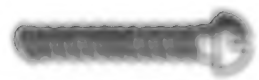
Split Lock Washer Washers

Shake Proof Washer

These are three types of washers. The flat washers are used under bolt heads and nuts. They provide larger bearing surfaces. They also prevent damage to surfaces of the metal that the bolt passes through.

The split lock washers are used under nuts. They grip the nut and the work and prevent loosening by vibration. One side digs into the nut and the other side into the work to prevent slipping.

Shake proof lock washers have teeth or legs. These teeth grip the nut and the work.



Button Head

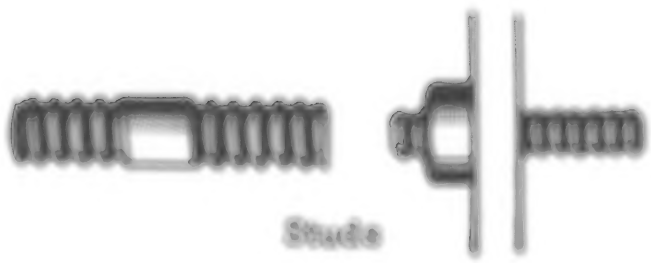
Hexagon Head

Flat Head

Fillister Head

Capscrews

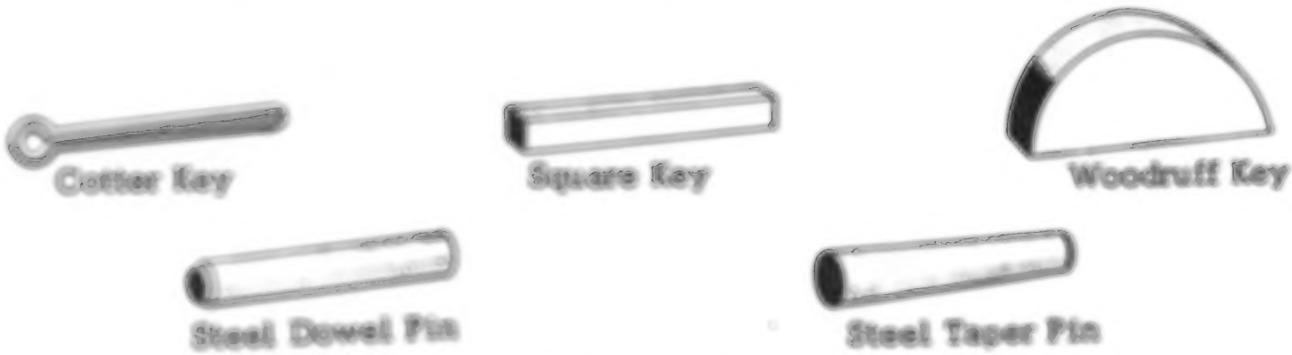
Capscrews hold parts of machines and engines together. There are some capscrews. They are screwed into tapped holes and are used without nuts. Often they are called tap bolts. Capscrews are used in the same ways that machine screws are used but are larger for heavier work.



Studs

These are studs. They could be called headless bolts. Both ends of studs are threaded. One end screws into a tapped hole and the other end takes a nut.

Studs are used to hold down cylinder heads of automobile and boat engines. The stud has an important advantage over the bolt. Even if the end that is screwed into the casting will not turn, the nut can be removed.



Pins and Keys

This drawing shows several pins and keys. Cotter keys are used for securing castellated nuts on bolts and rods. They are also used as stops and holders on rods and shafts.

Square keys and woodruff keys are used to prevent gears, pulleys, cams, and hand wheels from turning on a shaft. They must be fitted to seat properly. They can carry heavy loads.

Dowel pins are used to position and align parts or units being assembled. One end of the pin is usually a little larger than the specified size. This means the hole for the pin can be reamed to give a close fit.

Taper pins are used to secure pulleys and gears to shafts. They are also used to locate and position matching parts. Usually they have a taper of 1/4 inch per foot of length.

WHAT IS A MACHINE?

Typewriters and gasoline engines are machines, but so are hammers and screwdrivers. A machine is any device that helps us to work.

When we speak of work, we think of two things—force and motion.

A machine allows us to use less force to do a job. A machine can make the force greater. We can't lift an automobile alone, but with a jack, we can lift it.

It is hard work to carry a heavy box up a ladder. It is easy to lift the same heavy box if we tie one end of a rope around it, drape the rope over something, and pull down on the other end of the rope. As we pull down, the load goes up. A machine can change the direction in which the force is applied.

The simple machines are the lever, the wheel and axle, the pulley, the wedge, and the screw. Complex machines are just two or more simple machines put together.

FRICTION

If there were no friction, your feet would slide out from under you whenever you tried to walk. Without friction, screws and nails would fall out. The threads that form a piece of cloth would slide apart. Nothing could start moving. And anything that was already moving would keep on moving.

When one object moves over or through something else it meets resistance. This resistance is called friction. When an object is moving in one direction, friction will work in the opposite direction. Friction either slows down or stops the movement of an object.

When an automobile is traveling along a highway and the brakes are applied hard, the wheels lock and stop turning. Then the car skids to a stop. It stops because of the friction between the tires and the road. Tire makers try to increase this gripping power of their tires by adding grooves and ridges.

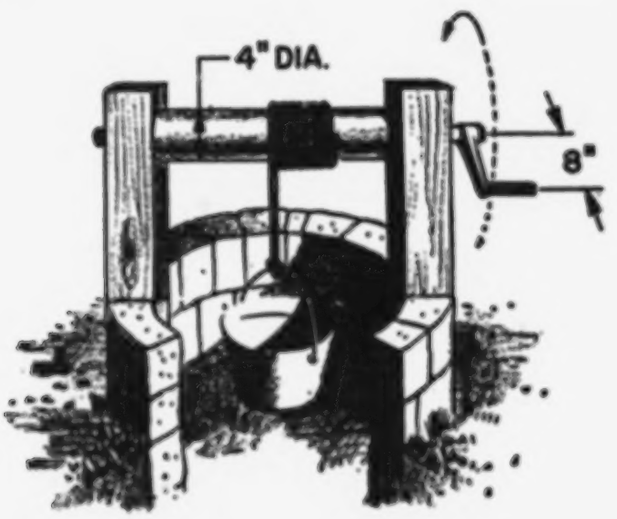
Friction changes mechanical energy into heat energy. Friction causes a match to burst into flame when it is struck. Friction also warms your hands when you rub them together.

REDUCING FRICTION

Any machine, no matter what kind, always does less work than the work done on it. Friction causes this loss of work. Engineers

are always trying to find ways to increase the amount of work machines do by reducing friction.

Let us suppose that a man wants to lift a 100-pound bucket of rocks out of a 10-foot well. If the windlass of the well is like the picture below, and if there is no friction, he would have to use 1/4 of 100 pounds, or 25 pounds, of force on the handle. He would have to turn the handle through 40 feet. This is because the radius of the handle is 8 inches and the radius (1/2 the diameter) of the windlass drum is 2 inches.



However, if the bearings of the windlass inside the two posts are hard to turn (because of friction), then more than 25 pounds of force is required. If this is 30 pounds, then the amount of work he does (input) is:

30 pounds times 40 feet = 1200 foot-pounds.

The amount of work he gets out of the windlass (output) is:

100 pounds times 10 feet = 1000 foot-pounds.

The difference is friction.

Rolling friction is a great deal less than sliding friction. Modern machines often have ball bearings or rollers between moving parts. This changes sliding action into rolling action.

Ball Bearings

Friction can also be reduced by making the surfaces that rub together as smooth as possible.

Friction between the layers of a liquid is less than friction between two solids. This fact has led to the development and use of liquids, such as greases and oils, as lubricants. Surfaces that touch each other are coated with lubricants. The lubricants actually keep the surfaces apart. The lubricant also reduces friction by filling in any tiny irregularities in the touching surfaces.

All of these ways of decreasing friction are used in modern machines. Surfaces are made smooth. Roller and ball bearings are used wherever possible. All of a machine's moving parts, even the ball bearings, are lubricated freely.

THE INCLINED PLANE

An inclined plane is just a straight sloping surface. Ramps, chutes, stairways, and even hillsides are all inclined planes. The inclined plane is stationary. It has no moving parts. It is used tc raise heavy weights and objects.

Suppose you wanted to lift a heavy barrel up to the tailgate of a truck. If it weighed 1000 pounds it would be very hard to lift.

An inclined plane

Much less effort is needed to slide or roll the barrel up an inclined plane than to lift it straight up. The less steep the inclined plane the easier it is. On the other hand, the steeper the inclined plane the harder it will be to get up on the truck.

The stairway in your house makes it easier to carry your weight up the inclined stairs than to climb straight up a ladder.

All sloping streets and roads are inclined planes. The slope or grade of a road is expressed in how much the road rises in 100 feet. If it rises 4 feet in 100 feet it is called a 4 percent grade.

Highway engineers try to keep all road grades as gentle as possible. Some highways have grades as high as 12 percent. Railroad grades are usually kept at 2 percent or less.

THE WEDGE

Many of our modern cutting tools are wedges. Some examples are knives, plows, axes, chisels, and saw teeth. Nails, bullets, straight pins, and a person's front teeth are also wedges.

The wedge is often thought of as a type of inclined plane. The wedge is pushed under the load instead of the load being pushed up the wedge or inclined plane.

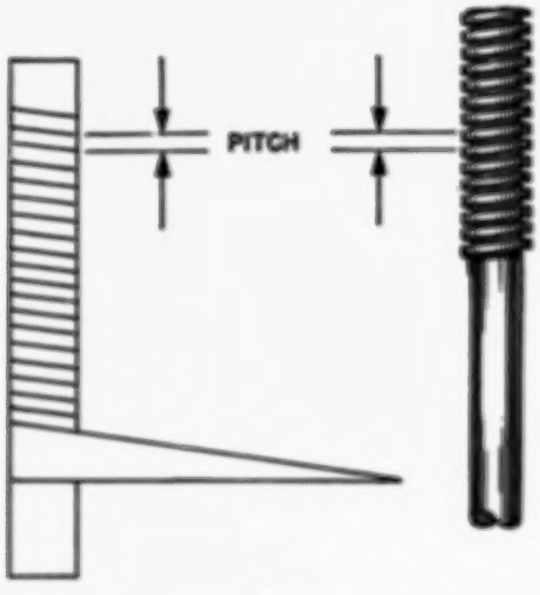
Some wedges are single inclined planes. An example is a chisel. Some wedges are two inclined planes joined base to base, like an ax or knife blade.

A great deal of force must be used with a wedge to overcome friction. To get a large mechanical advantage, the wedge must be as thin as possible.

If a log is split with a wedge 1 inch thick and 6 inches long, the wedge has to move 6 inches to spread the wood 1 inch. The effort must travel 6 times as far as the resistance. This means that 100 pounds applied to the end of the wedge will split the wood with a force of 600 pounds.

THE SCREW

The screw is a type of inclined plane. The plane in the screw is tightly wound around a rigid rod or cylinder. The edge of the plane is changed to form a helical ridge or spiral. This spiral is called the thread. The thread's turns are separated by a spiral groove. The spiral groove has the same width throughout the length of the screw. The width between the turns of the thread is called the pitch of the screw.

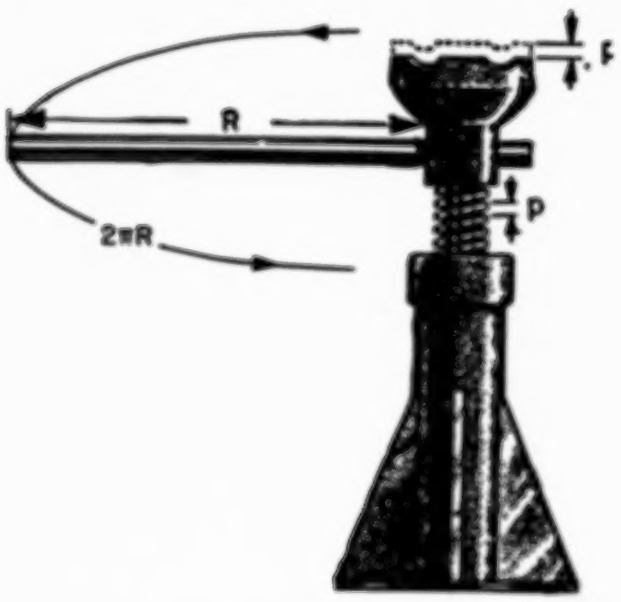


Screw

The screw can increase force a great deal. When a lever is used to turn the screw, the force is especially easy to increase. The real mechanical advantage is reduced greatly because of friction. A brace and bit is a combination of the lever and screw.

The picture shows this mechanical advantage. The distance between successive threads is called pitch. To raise a weight this amount, the handle must make one complete turn.

Jacks are made more powerful in two ways. One way is to make the handle longer. The other way is to make the inclined plane less steep. This is done by making more threads to the inch.



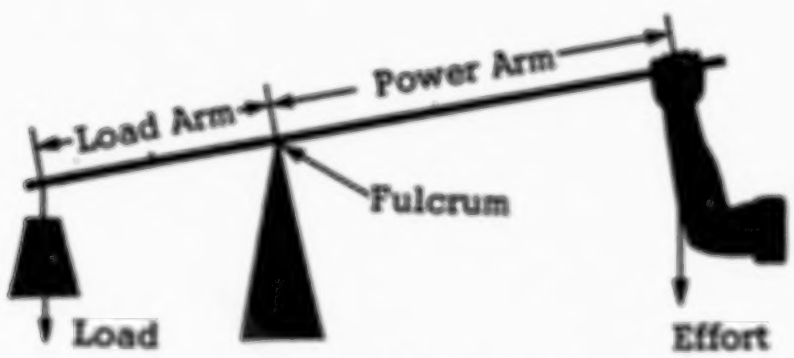
Jack

The basic idea of the screw is also used in automobile jacks, faucets, jar lids, swivel chairs, and, of course, wood and metal screws, nuts, and bolts.

THE PRINCIPLE OF THE LEVER

The simplest machine is the lever. Every day, you probably use many types of levers. Bottle openers, pliers, scissors, even some parts of your body, are levers. What is a lever? It is a stiff object, usually a pole, bar, or rod, that can turn about a fixed point, called its fulcrum.

A lever has two arms—the power arm and the load arm. The force applied at the end of the power arm lifts, moves, or balances the load. The power arm is the part of the lever between the fulcrum and the point where force is applied. The load arm is between the fulcrum and the load. The lever can be used to gain a mechanical advantage.



Lever

A lever's mechanical advantage depends on the relationship between the lengths of the power arm and the load arm. A mechanical advantage is obtained when the power arm is longer than the load arm. In this case the applied force will balance a load larger than it is.

The mechanical advantage is less than one when the load arm is longer than the power arm. The applied force must be larger than

the load. The lever used in this way increases speed but loses force. A large slow-moving force applied near the fulcrum can make a small load a longer distance from the fulcrum move quickly. This is the basic idea of the catapult.

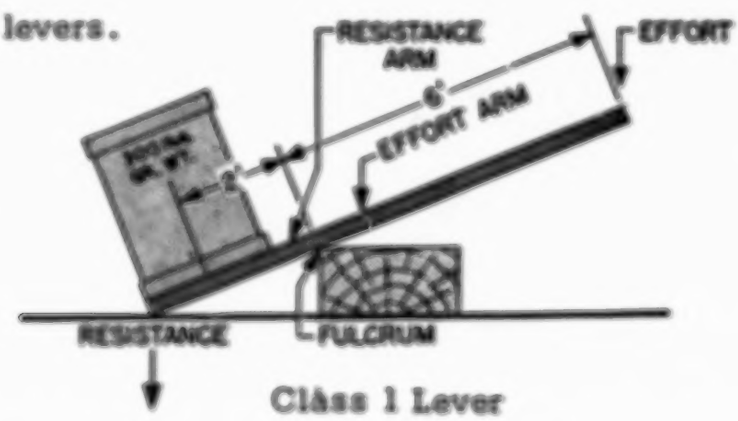
If both arms of a lever are the same length, the applied force will balance a load of the same size. This is the type of lever used in the balance scales and a seesaw.

THREE CLASSES OF LEVERS

There are three classes of levers. These classes are based upon where the fulcrum, or fixed point, is located in relation to the effort (force) and the load (resistance).

Class 1 levers. A first-class lever has its fulcrum located between the load and the applied force. If the power arm is longer than the load arm, force will be increased. If the power arm is shorter than the load arm, speed will be increased.

A seesaw is a first-class lever. When the force comes down, the load goes up. The force and the load always go in opposite directions. Scissors, balances, crowbars, and oars are examples of first-class levers.



Class 1 Lever

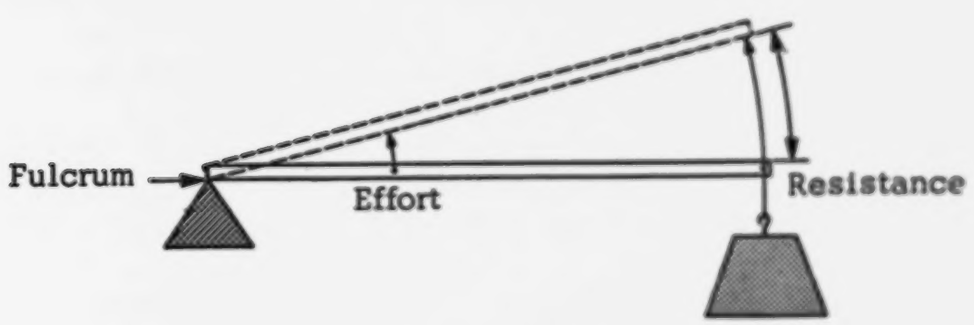
Class 2 levers. A second-class lever has its load placed between the applied force and the fulcrum. The second-class lever increases force but loses speed. This is because the effort is farther from the fulcrum than the load. The direction of motion, effort and resistance is always the same.

Some examples of second-class levers are nutcrackers, bottle openers, and wheelbarrows.

Class 2 Lever

Class 3 levers. A third-class lever has an applied force between the load and the fulcrum. This lever increases speed but loses force.

Some examples of third-class levers are mousetraps, baseball bats, shovels, and a person's jaw.

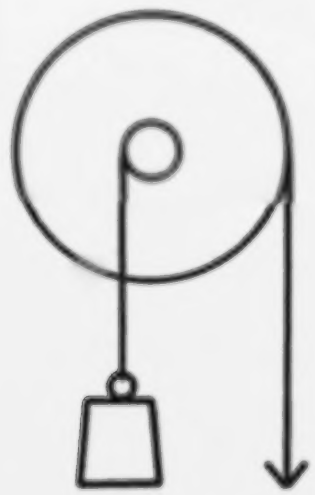


Class 3 Lever

THE PRINCIPLE OF THE WHEEL AND AXLE

A wheel and axle is a simple machine. This is a wheel which turns on an axle attached to its center. The diameter of the wheel is larger than the diameter of the axle. (The diameter is the measurement from one side to another, straight through the center.)

Sometimes the axle is shortened a great deal and really becomes a small wheel fixed securely to a larger wheel. Sometimes the wheel is changed by removing most of its body and leaving just a small part along one radius. (The radius is a straight line from the center to the edge.) In this case, the device is called a crank.



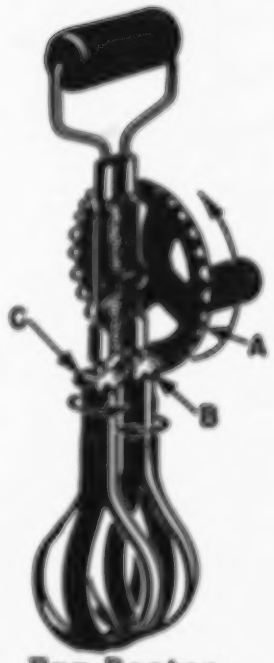
One way to use the wheel and axle is to attach a rope or cable to the wheel and wind the rope around the wheel's rim. Another rope is fastened to the axle and wound around in the opposite direction. The wheel and axle are fastened together securely. The axle turns whenever the wheel turns. The load, which is fastened to the rope around the axle, is lifted whenever force is applied to the rope around the wheel.

The wheel and axle is like a first-class lever. The wheel's radius is like the power arm of the lever. The axle's radius is like the load arm of the lever. The center, which is shared by wheel and axle, is the fulcrum. The mechanical advantage equals the length of the wheel's radius, the power arm, divided by the length of the axle's radius, the load arm.

The power arm is longer than the load arm when a force is applied to the wheel. Force is increased but speed is lost. The mechanical advantage is more than one. Sometimes force is applied to the axle. In this case the shorter arm is the power arm. When this happens, speed is increased but force is lost.

GEARS

Gears are used in many machines. An egg beater shows three things that gears do. Gears can change the direction of motion, increase or decrease the speed, and magnify or reduce the power.



Egg Beater

Gears also give you a positive drive. There can be creep or slip in a belt drive. But when gear teeth mesh—fit together—there can be no creep or slip.

Look at the way the arrows point in the picture. The crank turns counterclockwise. The 32 teeth on the large vertical gear A mesh with the 8 teeth on the right-hand horizontal gear B. If you look down on gear B you will see that as B turns in a clockwise direction its teeth fit into the spaces between the teeth of gear C. This fitting or meshing causes gear C to turn in the opposite direction. The turning or rotating of the crank handle has been transmitted or carried by gears to the beater blades, which also rotate.

Let's see how the gears change the speed. There are 32 teeth on gear A and 8 teeth on gear B. But the gears mesh, so that one complete turn of the handle results in four complete turns of gear B. One complete turn is called one revolution. Since gears B and C have the same number of teeth, one turn of B results in one turn of C. Thus the blades turn four times as fast as the crank.

Earlier you learned that when you use a third-class lever you increase speed but lose force. The same thing happens with an egg beater. The speed is increased but the amount of the force is changed. The force required to turn the handle is greater than the force applied to the batter by the blades.

TYPES OF GEARS

Gears are of various kinds. You should learn their names. In the picture below you see some gears that are used when the driving shaft and the driven shaft are parallel. Things are parallel when they stay the same distance apart from each other. At A in the picture there are two external spur gears, so named because they are in external or outside contact.

This arrangement of gears is the one most commonly used. The gears rotate in opposite directions.

Types of Gears

Above in B you see two spur gears in internal contact—the teeth on the large gear are on the inside of the rim. When internal gears are used, both gears rotate in the same direction. There is

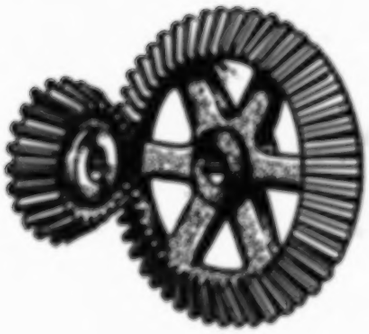
no reversal of rotation as there is with external gears. The smaller of the two spur gears is usually called a pinion.

The rack and pinion shown in C are both spur gears. The rack may be considered as a piece cut from a very large gear, or a gear flattened out. The rack-and-pinion arrangement is used to change circular motion into straight-line motion.

When spur gears mesh, the load is carried by the two teeth in contact at that instant. This results in the force being transferred from one gear to the other by a series of sharp jerks. To avoid the jerking, and to provide for smoother operation, helical (spiral or screw-type) gears are used, as shown in B and D.

With helical gears it is necessary to put a special thrust bearing at the end of the shaft to keep the shaft from moving along its length.

Thrust bearings are not needed if herringbone gears like those shown in E are used. This is really two helical gears put together. Since the teeth on each half of the gear are cut in opposite directions, each half counterbalances the other. Herringbone gears are used in most heavy machinery.



Bevel Gears

Worm and Spur Gear

When the shafts are not parallel, gears of the type shown in the figure above are used. Those shown at the left are bevel gears. The right-hand side shows a worm gear and a spur gear. One full revolution of the worm gear turns the spur gear ahead a distance equal to one tooth of the spur gear. If there are 40 teeth on the spur gear, the worm will have to turn 40 times to turn the spur gear one complete turn. Tremendous mechanical advantages can be obtained with this arrangement.

The worm gear above is single-threaded. Sometimes the worm gear may be double-threaded, or triple-threaded. Then the spur gear will be moved ahead two teeth or three teeth per turn of the worm gear.

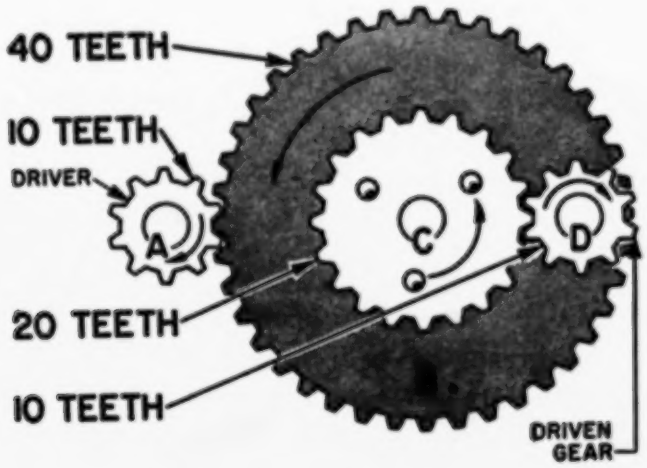
Worm drives are usually designed so that only the worm can be the driver—the spur cannot drive the worm. On a hoist, for example, you can raise or lower the load by pulling on the chain which turns the worm. However, if you let go of the chain, the load cannot drive the spur gear and cause the load to drop. This is a non-reversing worm drive.

CHANGING DIRECTION WITH GEARS

The crankshaft of an automobile engine can turn in only one direction. If you want the car to go backwards, the effect of the engine's rotation must be reversed. This is done by a reversing gear in the transmission, not by reversing the direction in which the crankshaft turns.

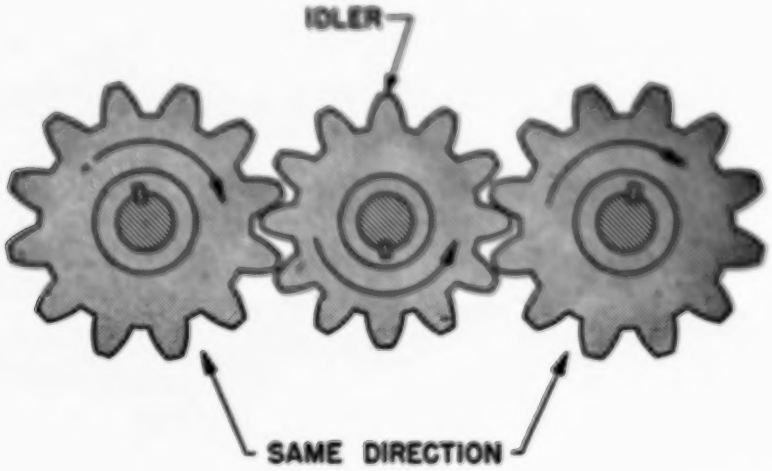
CHANGING SPEED WITH GEARS

As we have already seen in the egg beater, gears can be used to change speed of motion. Another example of this use of gears is found in a clock or watch. The mainspring slowly unwinds and causes the hour hand to make one revolution in 12 hours. Through a train or series of gears, the minute hand makes one revolution each hour, while the second hand goes around once each minute.



The figure above will help you to understand how speed changes are made possible. Gear A has 10 teeth which mesh with the 40 teeth on gear B. Gear A will have to rotate four times to

cause B to rotate once. Gear C is fixed to gear B and rotates with it so C will make the same number of revolutions as B. However, C has 20 teeth, and meshes with gear D which has only 10 teeth. So gear D turns twice as fast as gear C. Now if gear A turns at a speed of four revolutions per second, B will be rotated at one revolution per second. Gear C also moves at one revolution per second, and causes D to turn at two revolutions per second. So the end result is two revolutions per second after having started with four revolutions per second, even though the middle gears turn at only one revolution per second.



An idler gear

When two external gears mesh, they rotate in opposite directions. Often it is necessary to avoid this. It is avoided by putting a third gear, called an idler, between the two gears. The figure above shows an idler. But don't let this extra gear confuse you on speeds. Just forget the idler entirely. It doesn't change the gear ratio at all. The idler merely makes the driver gear and the driven gear turn in the same direction at the same speed.

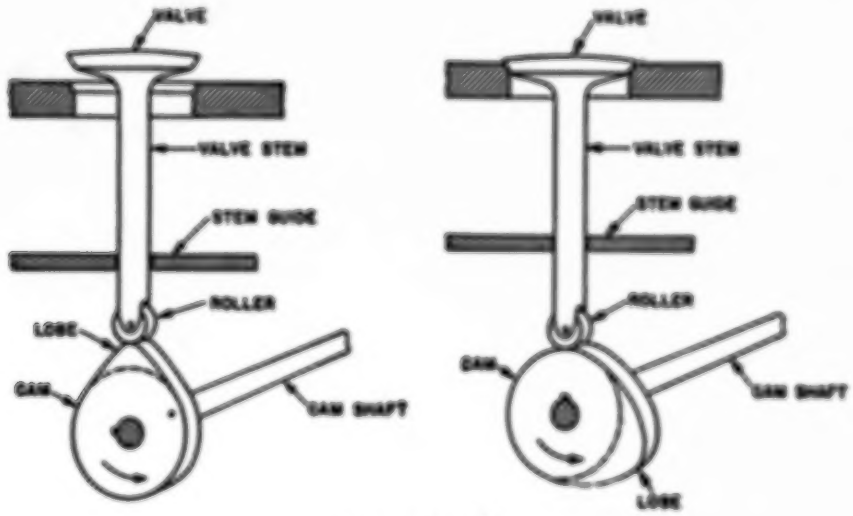
CONCLUSIONS ABOUT GEARS

Here are the important points to keep in mind about gears:

1. Gears can do a job for you by changing the direction, speed, or size of the force which you apply.
2. When two external gears mesh, they always turn in opposite directions. You can make two gears turn in the same direction by placing an idler gear between them.
3. When two internal gears mesh they always turn in the same direction.
4. When you set up a gear train to increase speed you reduce the effort.
5. On the other hand, when you reduce the speed you increase the effort.

CAMS

Gears are used to produce circular motion. Often, circular motion is changed into up-and-down or straight-line motion by using cams.



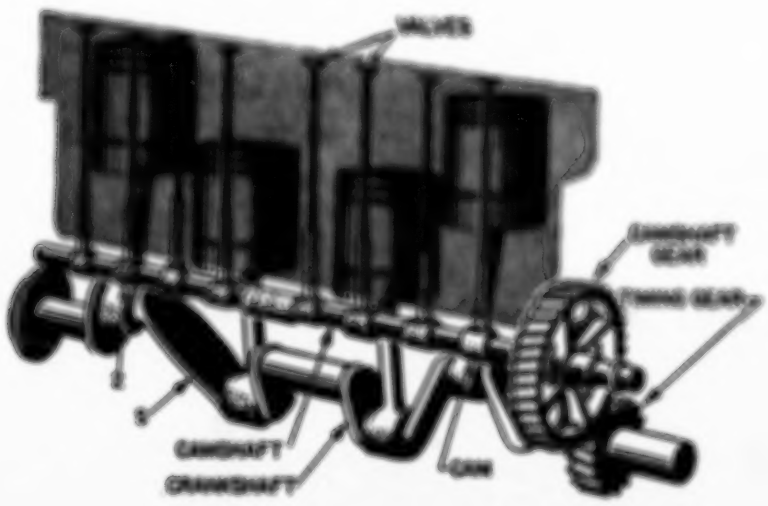
Camshaft

The camshaft in the picture above is turned by the camshaft gear. A cam is fixed or keyed to the shaft and turns with it. The cam has a pear or teardrop shape which is designed to move the

valve stem up and down, giving the valve a straight-line motion as the camshaft rotates.

When the camshaft rotates, the high point, or lobe, of the cam raises the valve to its open position. As the shaft continues to rotate, the high point of the cam is passed and the valve is lowered to the closed position.

Modern engines use hydraulic lifters to operate the valves. The principle is the same in all engines. The drawing above is used to illustrate the principle.



Automobile valve camshaft

A set of cams, two to a cylinder, driven by timing gears from the crankshaft, operate the exhaust and intake valves on the gasoline automobile engine shown in the picture above. Cams are widely used in machine tools and other devices to make rotating gears and shafts do up-and-down work.

THE PULLEY

The pulley is a simple machine. It is made up of a wheel, an axle, and a frame. In the wheel and axle machine, the wheel and axle are tightly joined together. In the pulley, the wheel and the axle are not tightly joined. The wheel can spin freely on the axle.

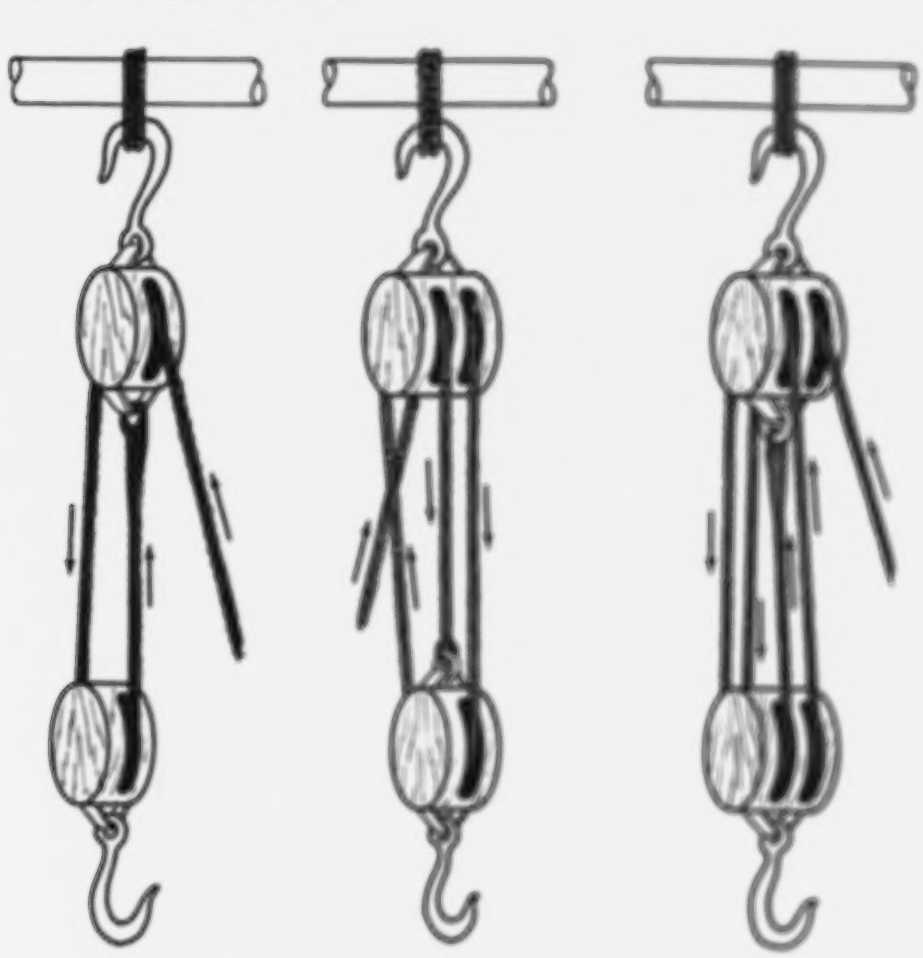
A rope or chain goes around the wheel's grooved rim. A force is applied at one end of the rope and a load is lifted at the other. Several pulleys are often used at the same time.

Fixed Pulley

A fixed pulley is one that is hung from a stationary object. (A stationary object is one that stays in the same place.) Force applied to one end of the rope in a single fixed pulley can balance an equal weight on the other end of the rope.

The fixed pulley cannot increase speed or force. Its value is that a load can be lifted by pulling down on a rope.

A movable pulley has a load hung directly to the frame of the pulley. One end of the rope is fastened to a fixed object. The rope goes around the wheel of the pulley and back toward the fixed object. A load twice as large as the force can be lifted. This pulley has a mechanical advantage of two.



Pulley Combinations

Fixed and movable pulleys can be combined to get larger mechanical advantages. The mechanical advantage of a pulley system is very easy to figure. All you do is to count the number of parts of the rope holding up the movable block.

For example, the left-hand picture of the pulley combinations shows two parts (or pieces) of rope coming from the movable block. This means that this arrangement gives a two to one mechanical advantage. Sometimes there are three parts of the rope leading from the movable block, like in the center picture of the pulley combinations. This would give a three to one advantage. Four parts would give a four to one advantage, and so forth.

The work a machine does cannot be greater than the amount of work done on it or put into it. This means that if the mechanical advantage of a pulley system is 4, the applied force must move four times as far as the load. If the mechanical advantage is 2, the effort must move twice as far, and so forth.

To get large mechanical advantages, a pulley would not be very practical. The applied force would have to move too long a distance to lift the load.

TRACTORS

Some tractors are big and some are small. Some do just one kind of work and others do many kinds. You will see in the pages which follow many kinds of tractors and many kinds of farm equipment used with tractors. It is hard for people who live in the city to imagine just how many things can be done with tractors.

Henry Ford and his son produced a tractor about fifty years ago. It was one of the first small and inexpensive machines for use on small farms. It ran on either gasoline or kerosene and had a 22-horsepower engine. Ford's tractor did a lot toward replacing the horse. Many inventions have greatly improved the modern farm tractor.

The dictionary says that a tractor is a machine that draws a load. Most of the time we think of a tractor as a farm machine. The farm tractor is very necessary to the modern farmer. Because of the development of the tractor, fewer and fewer horses are used on American farms.

Cub Lo-Boy Tractor

The International Harvester Cub Lo-Boy is a small tractor. It has good stability, which means it cannot be easily turned over. The Cub Lo-Boy is only 42 inches high at the hood. Even though it is small, the Lo-Boy has 12.8 horsepower.

The Lo-Boy uses fast-acting hydraulic power to operate its attachments. Hydraulic power is power from the force of a liquid. The hydraulic power is available whenever the engine is running.

The driver can work faster because the direct-drive gear pump saves effort. The double-acting cylinder lifts and lowers equipment easily. The cylinders can also apply pressure to hold the blade down to its work. Controls are arranged for easy fingertip operation. To raise, lower, or adjust equipment, the driver need only move a small lever.

The Lo-Boy can be equipped for many jobs. It can haul 1-1/4 tons. It can mow large areas quickly, dig post holes, and cut weeds, tall grass, and brush. It can be outfitted to spray-paint fences or spray insecticides. With special equipment, it can cut up fallen trees, cut up lumpy ground, or mix concrete. It can also be used for moving dirt, preparing seedbeds, and many other jobs.

The Cub Lo-Boy is unusual because it has the engine off-center. This gives the operator a clear view of his work. Many of the features of the tractor are given in the table below.

INTERNATIONAL CUB LO-BOY

SPECIFICATIONS

GENERAL	
Horsepower, maximum*	
Drawbar	10.08
Belt	10.75
Flywheel (net)	12.8
Forward Speeds, mph**	2.3, 3.1, 6.9
Reverse speed, mph**	2.6

*At 60° F. and barometric pressure of 29.92 inches of mercury.
**Specifications affected by tire sizes are based on 8-24-in., industrial tread, rear tires and 4.00-12-in. front tires.

ENGINE

Horsepower, maximum flywheel	12.8
Bore and stroke, inches	2-5/8 x 2-3/4
Number of cylinders	4
Piston displacement, cubic inches	60
Engine rpm, rated full load governed speed range	1,000 to 1,800
Compression ratio	6.5 to 1
Lubrication:	
Type	Pressure
Crankcase capacity, quarts	3
Oil Filter	Replaceable element
Recommended oil changes, hours	150
Clutch (single-plate, foot-operated), diameter, inches	6-1/2
Cooling system:	
Type	Thermosiphon radiator and fan
Capacity, quarts	9-3/4

DIMENSIONS AND WEIGHTS

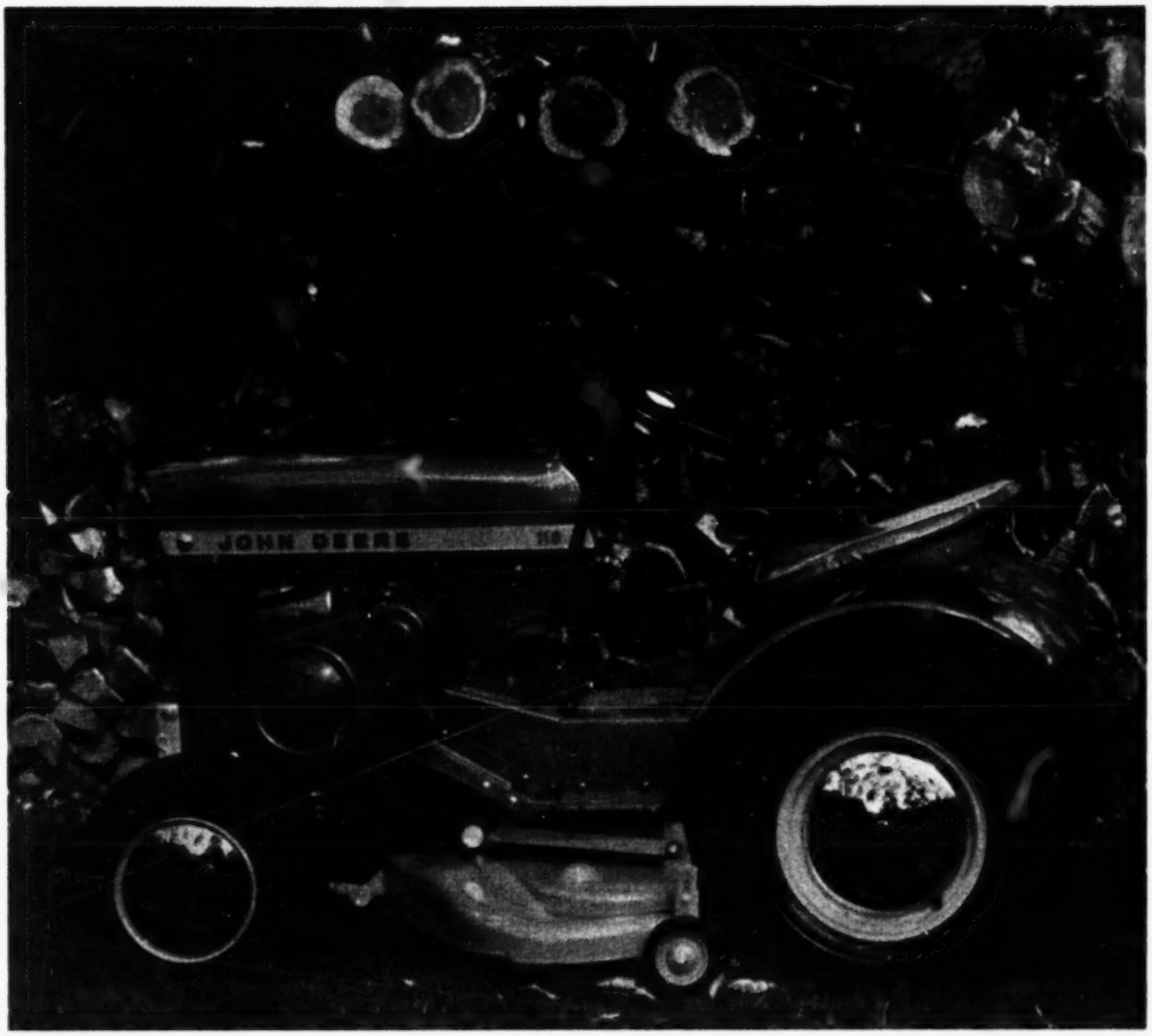
Wheelbase, inches	62
Length, inches	97
Width, inches:	
Minimum tread	48-3/8
Maximum tread	64-3/8
Height, inches (top of steering wheel)	55-1/4
Weight, pounds (depending on equipment and less fuel and water)	1,190 to 1,580

CHASSIS

Brakes	2 foot-operated brakes on bull pinion shafts
Steering gear	Enclosed-worm
Fuel tank capacity, gallons	7-1/2
Air cleaner	Oil-bath type
Power take-off, rpm	1,800
Belt pulley, rpm	1,487
Belt speed, feet per minute (7-5/8-inch pulley)	2,968
Clearance under front axle, inches	13-3/4
Turning radius, with brake applied, feet	7-1/2
Wheel treads, inches:	
Rear, by 4-inch intervals	40 to 56
Front, regular	43 to 49
Front, adjustable axle, by 4-inch intervals	39 to 55
Touch-Control hydraulic system: capacity, pints	3-1/2

BASIC EQUIPMENT:

Gasoline engine. Under-axle muffler. Standard drawbar. Non-adjustable front axle. Magneto type ignition. Non-upholstered, pan-type seat. Brakes. Rear wheel tread adjustment. 8-24-inch rear tires. 4-12-inch front tires.



110 Lawn and Garden Tractor

The John Deere 110 Lawn and Garden Tractor is designed for use around the grounds of large homes. It is an 8-horsepower tractor with 4-speed transmission.

Independent ground-speed control allows slow speed for tough jobs without reducing engine speed or power. There is a gear for almost every job, from 6.5 miles per hour (m.p.h.) down to a slow 1/3 m.p.h.

This tractor has many safety features. It cannot be started without the removable key. The engine will not start if the rotary mower drive is engaged or if the tractor is in gear. Dangerous "jump-starts" are eliminated by this feature.

The 110 Lawn and Garden Tractor has extra-large high-flotation tires. It can turn in a very small space, allowing the driver to mow close to trees and shrubs.

This tractor can be used safely on moderately steep hillsides. The rear-wheel tread can give up to six extra inches of hillside cling with a slight adjustment.

The three-bladed rotary mower cuts a 38-inch swath. Blades overlap one inch. There is a large guide arrow which makes it easy to keep the mower on target. The safety chute cannot be taken off and extends five inches past the tip of the blade.

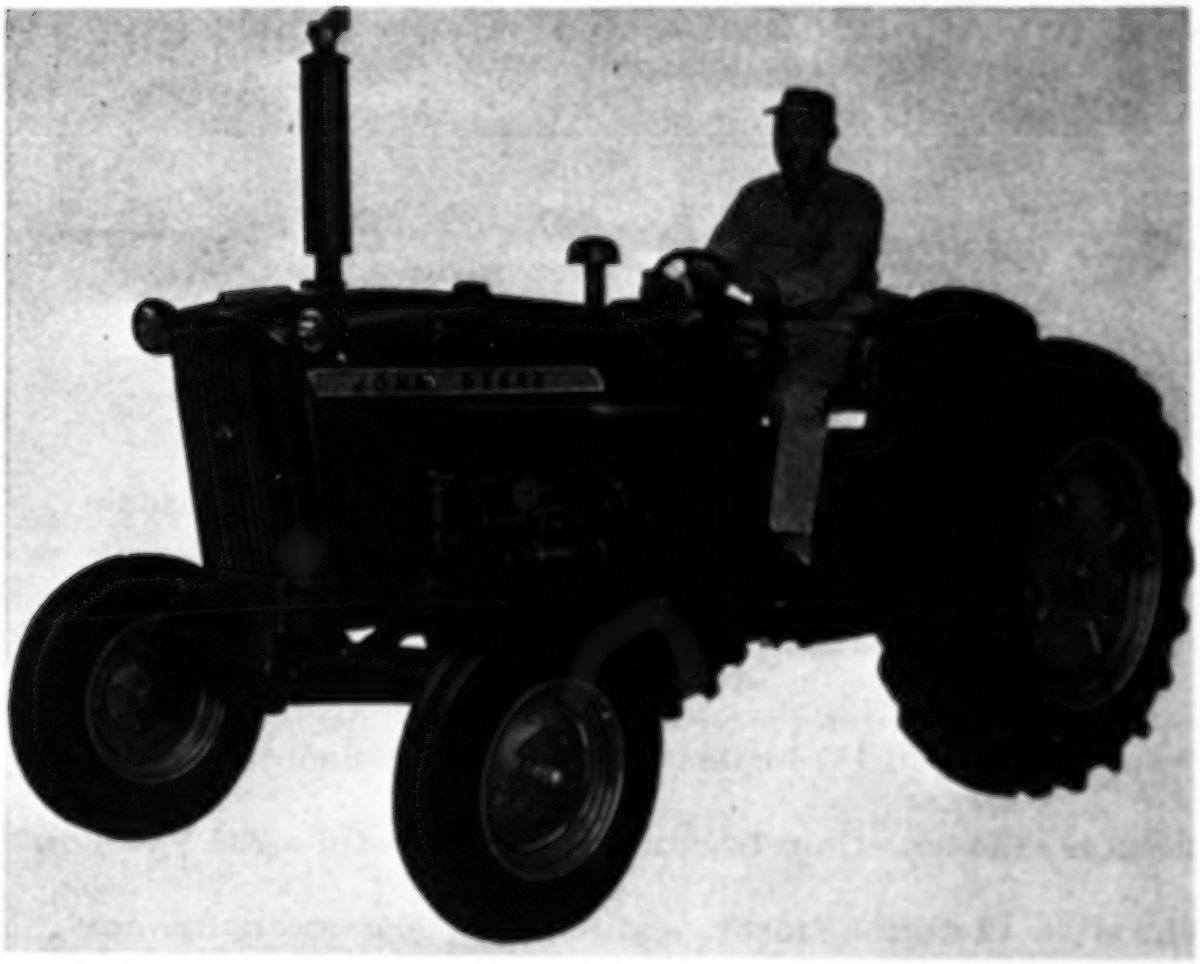
This tractor with a few attachments can be used for mowing; clearing snow; leveling soil and gravel; hauling firewood, sand, or anything up to 900 pounds; spraying; and for fast seedbed preparation as well as soil and crop cultivation.

1010 Row-Crop Tractor

The John Deere 1010 Row-Crop Tractor is designed to handle almost any job on a family-sized farm. It may have either a gas engine or a diesel engine. There is a five-speed transmission. Speed ranges from 1 to 15.8 miles per hour for efficient use with attachments. The Row-Crop Tractor can be used with a 237 Two-Row Corn Picker, a 12 Cotton Picker, and two- and four-row cultivators. Single or dual rockshaft and remote cylinder control are provided by the hydraulic system. A rockshaft is a machine shaft that rocks back and forth instead of turning.

It is possible to till the land evenly under many different types of soil and surface conditions because of Load-and-Depth Control.

An option is something that is not standard equipment, but which is available. Options include power steering and a deluxe "arm chair" seat. Wheel weights are available for the added pull necessary for some jobs. Four front-wheel options are available. The wheels may be on a wide or extra-wide axle, may be regular dual wheels, may have one wheel slightly raised, or may have a single wheel.



1010 Row-Crop Utility Tractor

The John Deere 1010 Row-Crop Utility Tractor is an all-purpose tractor. It has a variable-speed engine. The engine can be diesel or gasoline and delivers about 36 horsepower. It has a five-

speed transmission. Up to three "line" hydraulic circuits, each independent, are available. There is a hand-lever clutch for the power take-off. There is either single or dual rockshaft. It also has a three-point hitch for fast coupling of farm tools.

This tractor offers Load-and-Depth Control, power-adjusted sliding hub, or new eight-position demountable-rim rear wheels. A sweptback or straight front axle is available.

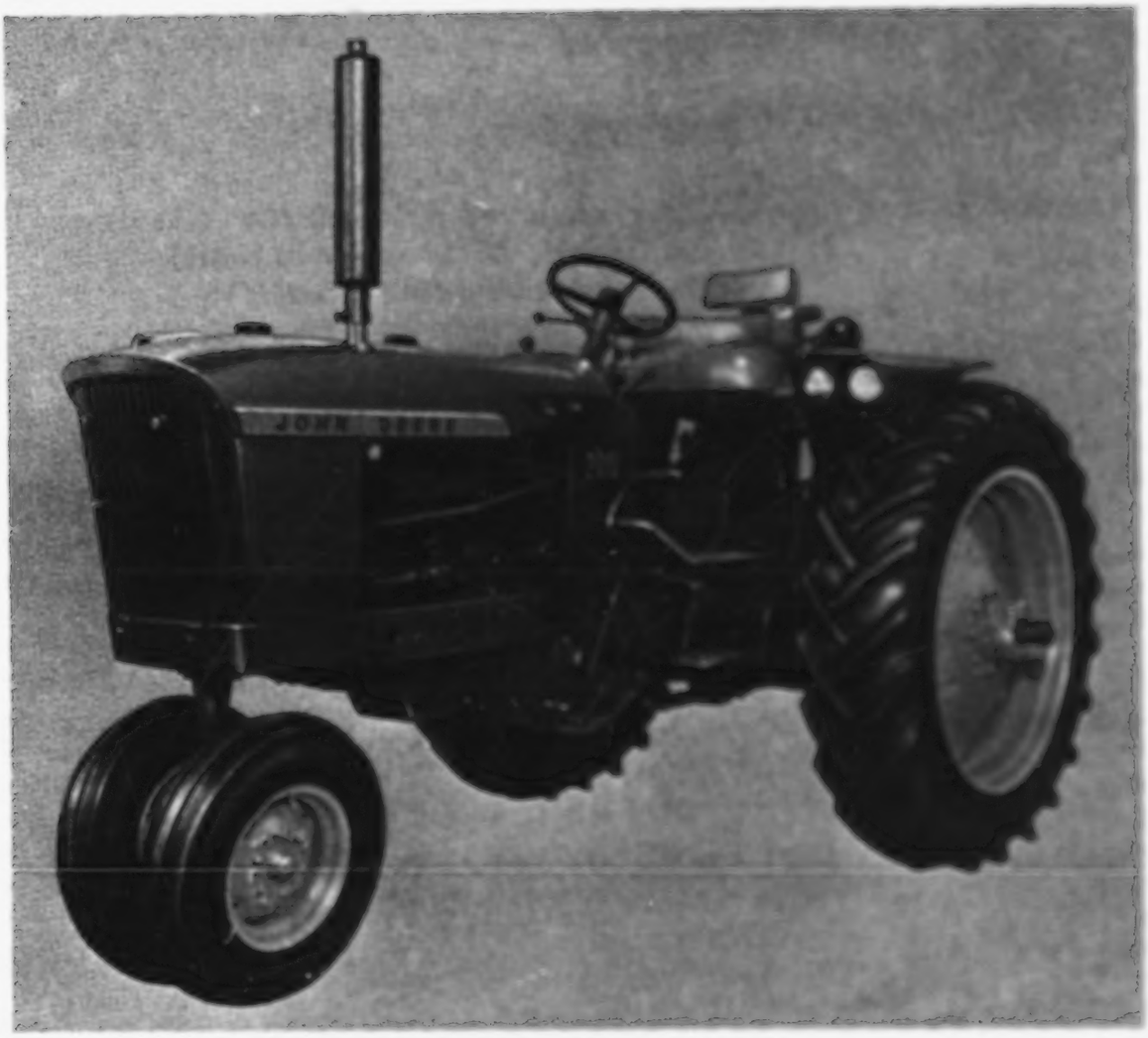
Although the Row-Crop Utility Tractor is extra low, it has 20-inch clearance. It can handle two- or four-row cultivators. The cultivators can be mounted in the rear or in the front.

1010 ROW-CROP & ROW-CROP UTILITY TRACTORS

SPECIFICATIONS

PERFORMANCE	Maximum observed h.p.: Gasoline, 36.13; Diesel, 35.99
ENGINE	Vertical, 4-cylinder, valve-in-head, 4-stroke cycle. Full-governed operating speed range, 1500 to 2500 rpm. SAE-PTO speed, 1900 rpm.
TRANSMISSION	Selective sliding gear type, 5 forward speed selections and reverse.
GROUND SPEEDS	Approximately 1 to 15-3/4 mph at engine speeds of 1500 to 2500 rpm.
CLUTCH	Foot-operated automotive type with single 10-inch plate.
BRAKES	Self-energizing disk type, foot-operated individually or simultaneously.

POWER TAKE-OFF	Special equipment: Transmission-driven 540 rpm, or, on Row-Crop and Row-Crop Utility, independent "live" 540 - 1000 rpm with hand-lever clutch.	
HYDRAULIC SYSTEM	Single or dual hydraulic system; remote cylinder control.	
ELECTRICAL SYSTEM	12-volt battery with generator and starter.	
CAPACITIES (U.S. Standard)	Cooling system, 2-3/4 gal. Fuel tank, 12 gal. Crankcase including filter, 5 qts. Transmission, with 540 rpm PTO, 17 qts.	
TIRES, Rear	11.2-36, 4-ply; 12.4-36, 4-ply; 13.9-36, 4- and 6-ply	12.4-28, 4-ply; 13.6-28, 4-ply
TIRES, Front	6.00-14, 4- and 6-ply; 6.50-16, 8-ply, and 9.00-10, 8-ply (single wheel)	5.00-15, 4-ply; 6.00-16, 4- and 6-ply
DIMENSIONS (Inches)	With 12.4-36 and 6.00-14 tires	With 13.6-28 and 6.00-16 tires
Height to top of hood	58-7/8	55-1/4
Over-all height	75-3/8 (gas); 79 (Diesel)	71-3/4 (gas); 75-7/16 (Diesel)
Over-all width (minimum)	81-1/8	Demountable rims, 69; power-adj., 75-1/4
Over-all length with 3-point hitch	135-9/16	131-1/2
Wheelbase	85	Straight axle, 80-3/4; sweptback axle, 76-1/4
Clearance	23-3/4 (wide front axle)	19-5/8 (front axle)
SHIPPING WEIGHTS (Approximate lbs.)	3865, gas; 3950, Diesel	3790, gas; 3880, Diesel



2010 Row-Crop Tractor

The John Deere 2010 Row-Crop Tractor is useful for large or small farms. It has a 4-cylinder, variable-speed, 45-horsepower engine. The engine may be either gasoline, diesel, or LP-gas. It has power steering. It is a very versatile tractor. The specifications for this tractor with its three types of engines are given on the next pages.

2010 ROW-CROP & ROW-CROP UTILITY TRACTORS

SPECIFICATIONS

PERFORMANCE

Maximum observed h.p. at PTO: Gasoline, 46.86; Diesel, 46.67 (official tests); LP-Gas, 45 (factory observed).

ENGINE

Vertical, 4-cylinder, valve-in-head, 4-stroke cycle. Governed engine-speed range, 600 to 2500 rpm. Operating range, 1500 to 2500 rpm. ASAE-SAE PTO speed, 1900 rpm.

	Gasoline	LP-Gas	Diesel
Bore & Stroke (In.)	3-5/8 x 3-1/2	3-5/8 x 3-1/2	3-7/8 x 3-1/2
Compression Ratio	7.9 to 1	8.9 to 1	19 to 1
Displacement (Cu. In.)	145	145	165

TRANSMISSION

Syncro-Range, regular or slow-speed: constant-mesh, synchronized shifting in 4 ranges: 8 forward, 3 reverse.

GROUND SPEEDS (MPH)

Regular transmission (Row-Crop Utility): 1.1 to 13.5 (13.6-28 rear tires at 1500 to 2500 engine rpm). Slow-speed: .66 at 1500 rpm.

POWER TAKE-OFF

Special equipment. Independent, engine driven, dual-speed (540 and 1000 rpm).

CLUTCH

Foot-operated, spring-loaded, dry disk.

BRAKES

Self-energizing disk type, foot-operated individually or simultaneously.

ELECTRICAL SYSTEM

12-volt battery with generator and starter.

HYDRAULIC SYSTEM

Special equipment: Single or dual power lift; front rockshaft; remote cylinder.

INSTRUMENT PANEL

Standard equipment includes speed-hour meter; indicator lights for oil pressure and generator; water temperature gauge; light switch; safety key starter switch. Electric fuel gauge and cigarette lighter are extra.

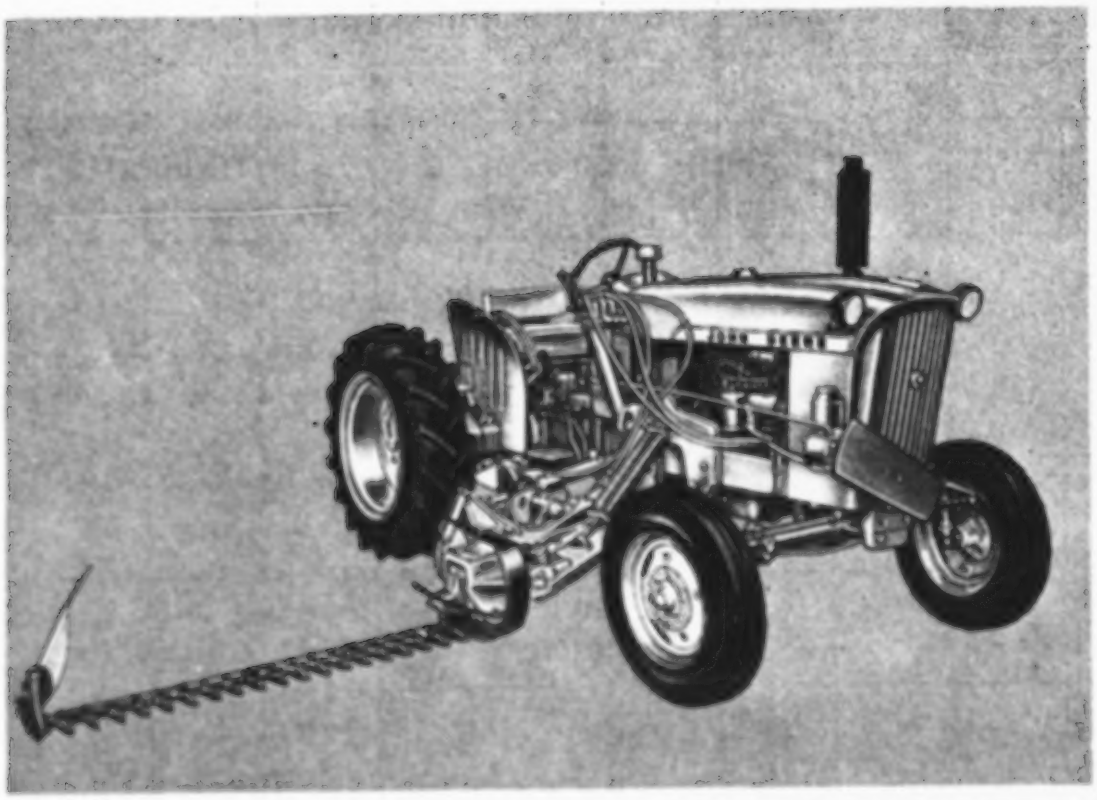
CAPACITIES (U.S. Standard)

Cooling system, 3 gal. Fuel tank, gasoline and Diesel, 16 gal.; LP-Gas, 22.6 gal. (80% Fill). Crankcase including filter, 5 qts. Transmission-hydraulic system, 8 gal.

DRAWBAR, 3-POINT HITCH, BELT PULLEY	Special equipment; conform to ASAE-SAE standards.	
	2010 ROW-CROP	2010 ROW-CROP UTILITY
TIRES	Front: 6:00 x 14, 4- and 6-ply; 6.50 x 16, 8-ply or 9:00 x 10, 8-ply (single wheel).	Front: 6:00 x 16, 4- and 6-ply; 6.50 x 16, 6-ply; 7.50 x 15, 6-ply.
	Rear: 11.2-36, 4-ply; 12.4-36, 4-ply; 13.9-36, 4- and 6-ply.	Rear: 12.4-28, 4-ply; 13.6-28, 4-ply; 14.9-28, 6-ply; 16.9-26, 6-ply.
DIMENSIONS:		
Height to Top of Hood	60-1/16 inches	55-5/8 inches
Over-All Height	85-3/4 inches	76-1/4 inches
Over-All Width	86 inches	71 inches
Over-All Length	132 inches	127-1/4 inches (straight axle)
Wheelbase	90 inches	86-7/8 inches (straight axle); 91-1/2 inches (sweptback axle)
Clearance (Under Axle)	23-3/4 inches (wide front axle)	19-5/8 inches
SHIPPING WEIGHTS (Approximate)	Diesel, 4775 lb.; Gasoline, 4670 lb.; LP-Gas, 4845 lb.	Diesel, 4900 lb.; Gasoline, 4800 lb.; LP-Gas, 4970 lb.

Features of the 2010 Tractor

1. Hydraulic controls (Row-Crop)
2. Full-view panel
3. Transmission shift lever
4. Variable-speed throttle
5. PTO lever
6. Hydraulic pump disconnect
7. Clutch pedal
8. Brake pedals
9. Roomy platform
10. Hydraulic selector lever
11. "Floating" posture seat
12. Easy-mounting handhold



1010 Highway Tractor Mower

The John Deere 1010 Highway Tractor Mower is built close to the ground and has a good distribution of weight which keeps it from turning over. It turns around in a 16-foot circle. The Highway Tractor Mower has a 41.5-horsepower engine, which may be either diesel or gasoline.

This tractor has a fast hydraulic lift for its cutter bar. It mows hillsides and ditches easily. It can mow above curbs and at heights to 12.6 inches with the cutter bar level or raised.

FEATURES

Low center of gravity, good weight distribution for excellent stability

Eight-foot turning radius

Choice of hydraulic cutter-bar drive or V-belt drive from power take-off

Fast, hydraulic lift—mows ditches and hillsides easily

Independently controlled inner and outer shoes

Mows above curbs and at heights to 12.6 inches with cutter bar level or raised

Safety cutter-bar breakaway

41.5 engine h.p., Diesel or gasoline

SPECIFICATIONS

Tractor ..... 41.5 engine h.p. Diesel or gasoline
Cutter bar:
  Length ..... 5, 6, or 7 ft.
  Type ..... Heavy-duty
  Stroke ..... 3-3/4 in. with built-in knife register and lead
  Tilt ..... 6 degrees up; 7 degrees down
  Breakaway ..... 60 degrees
Cutter-bar drive (counterbalanced, double-throw crankshaft):
  Options ..... Hydraulic 10 h.p. motor, or V-belt from tractor PTO
Cutting range (hydraulic lift):

	Up-Angle	Down-Angle
Inner shoe at ground level	43 degrees	60 degrees
Inner shoe at max. lift	36 degrees	67 degrees
Inner shoe at max. depth	81 degrees	22 degrees

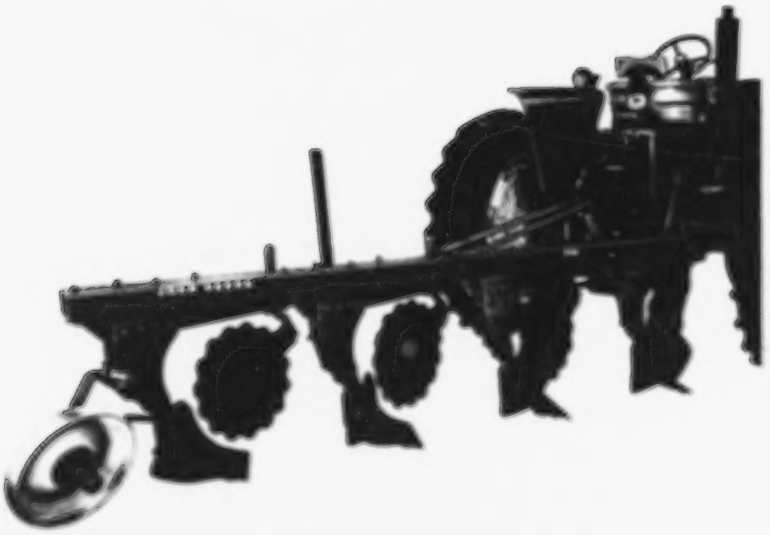
Cutting Height
  (at inner shoe) ... 6.9 in. below ground level to 12.6 in. above ground level
Hydraulic system (independent of tractor's hydraulic system):
  For hydraulically-driven mower:
    Pump ..... Front-mounted, 14.5 gpm
    Cutter-bar drive motor ..... 10 h.p., 800-900 rpm
    Reservoir ..... 7 gal. (approx.)
    Valves ..... Lift cylinder valve, cutter-bar drive valve, priority valve for lift cylinders (provides 1-3/4 gpm flow)
  For mechanically-driven mower:
    Pump and reservoir (front-mounted combination unit, 2 gpm)
    Valve ..... Lift cylinder valve

Shipping weight (with 5-foot bar), approx.
  Hydraulically driven mower ..... 2900 lb.
  Mechanically driven mower ..... 3150 lb.
Special equipment:
  Knife carrier
  Bumper for pump
  Chromed sections (not factory installed)

TRACTOR EQUIPMENT

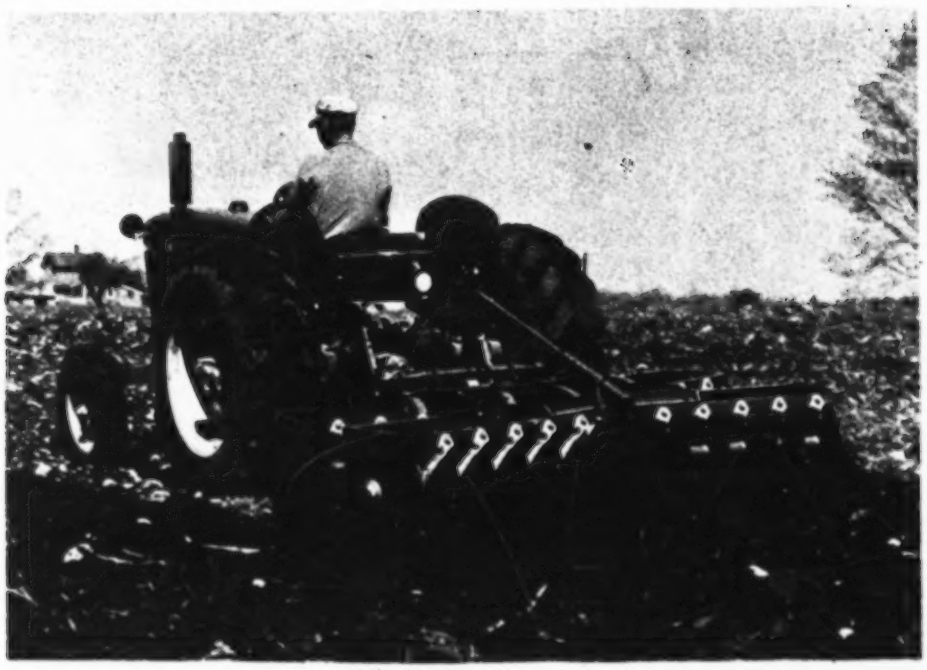
Usually farm tractors are engines mounted on wheels. In order to do any work, something must be hitched to them. In the following pages are examples of some of the equipment that can be used with a tractor.

This particular set of equipment was made by the John Deere Tractor Company for use with its line of tractors. Similar equipment is made by many other manufacturers.



Moldboard Plows

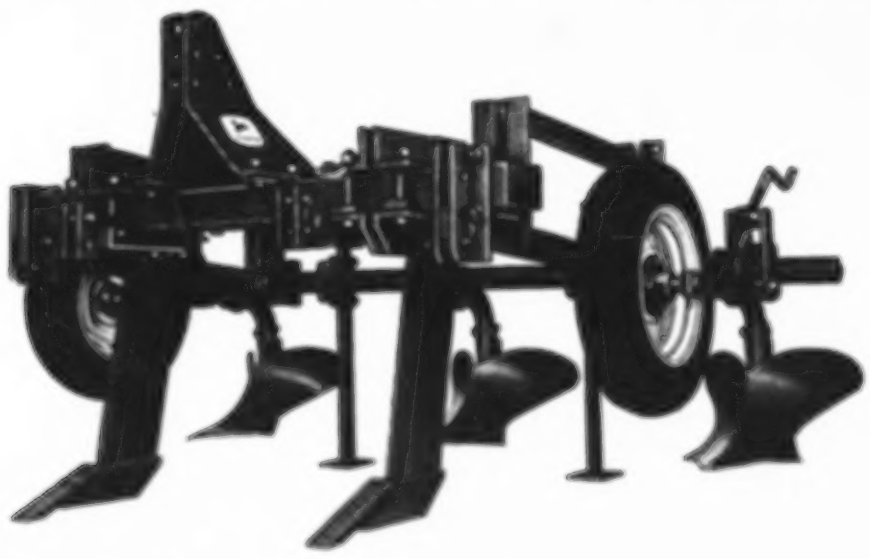
F115 and F125 series Moldboard Plows have unusual clearances, so they can run over objects as high as 28 inches without touching them. These plows are good soil conditioners and are easy to pull. Therefore, they are economical to operate.



Disk Harrow

Harrows

Harrows are used to break up the ground and to make fields level for planting. There are several kinds of harrows, all of which do more-or-less the same job. The disk harrow is shown here. There is also a spike-tooth harrow, a tine-tooth harrow, and a spring-tooth harrow.

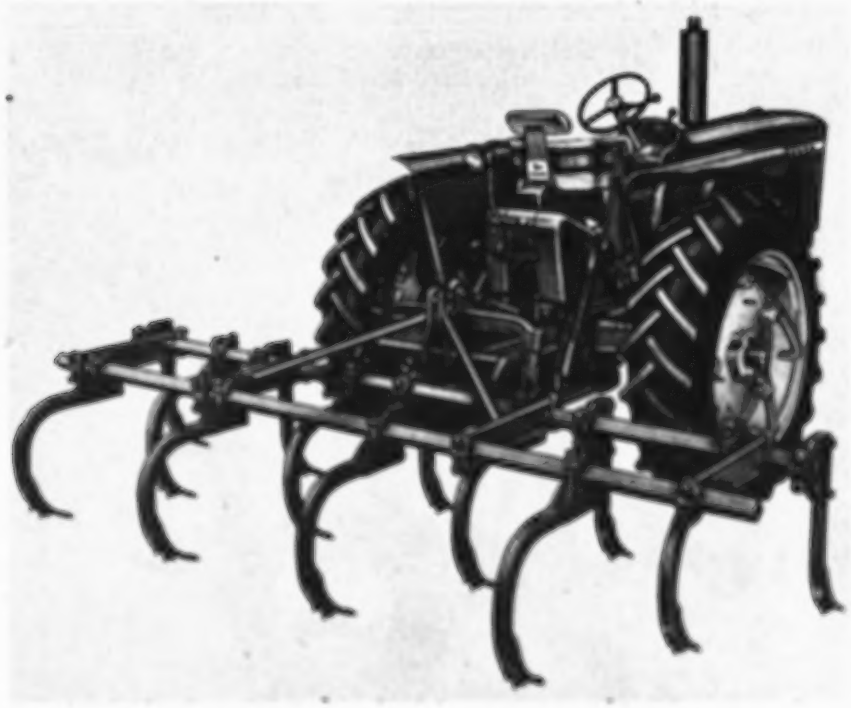


Flexible Toolbar Bedder

The 23-2FK Flexible Toolbar Bedders do two jobs. They open the subsoil and then build beds directly over the subsoil tracks. They dig up the ground as deep as 24 inches to improve water and root penetration.

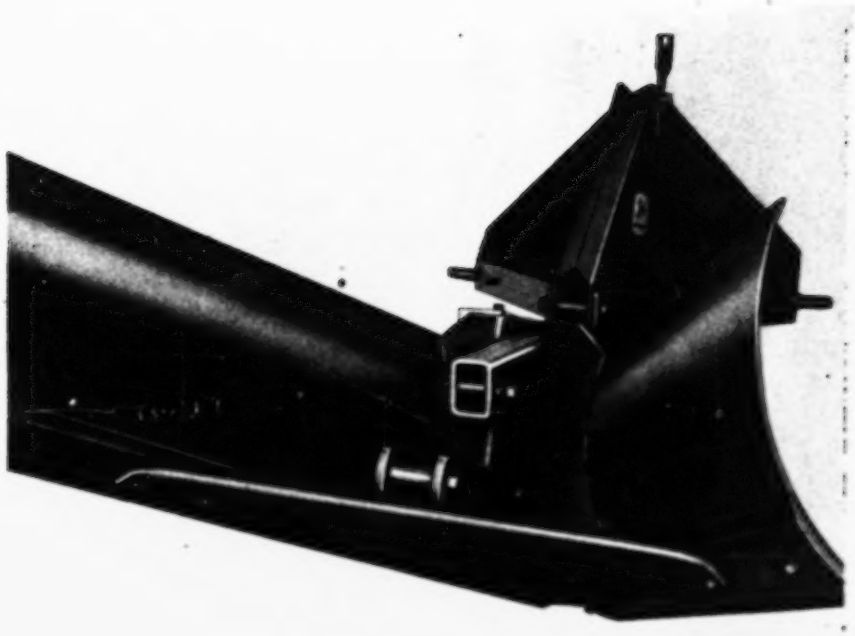
Bedder-Lister

The F-888 Bedder-Lister machine as shown above allows a farmer to plant eight rows at a time. The rows can be from 38 to 49 inches apart.



Tool Bar

The 400B Tool Bar is attached to the tractor. It has a very complete choice of tools with it. These tools can be used for tilling, planting, or other similar uses. The depth to which the tools dig is controlled hydraulically.

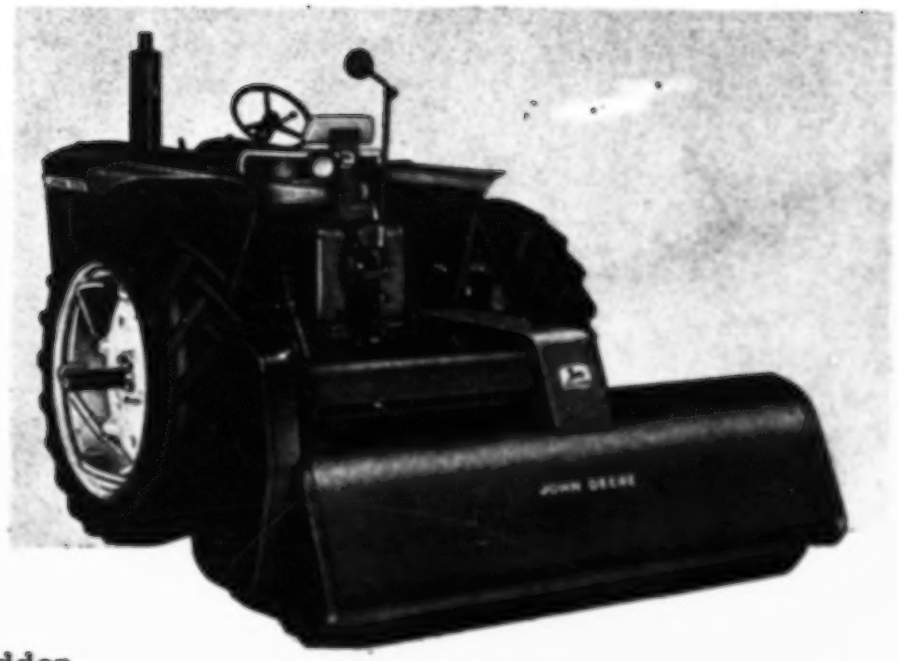


Ditchers

The 8M Ditcher is used with large tractors and the No. 10 with small tractors. These ditchers make and maintain ditches used to drain off water either from the fields or along the road. The 8M Ditcher can make ditches up to 24 inches deep, while the No. 10 makes ditches 16 inches deep.

Cultivator

The C-10 Field Cultivator is an extra-heavy-duty cultivator. It is used in the field for killing stubborn weeds, working fallow fields, mulching stubble, and reclaiming pasture and alfalfa. It is also used in making deep seedbeds.



Flail Shredder

The 26 Flail Shredder is used to shred cornstalks, cotton-stalks, beet tops, and light brush. It can also be used for clipping pasture. The shredder cuts a seven-foot path with its two-banked precision-balanced rotor, equipped with 50 double-edged knives.

Loader

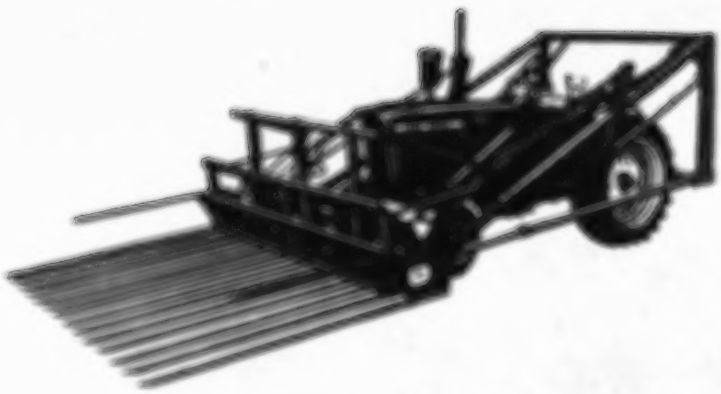
This is a 36-A Loader. It is used to load dirt or crops into a truck or wagon. This loader can lift its 1600-pound load about nine and a half feet above the ground. Some loaders can be used for digging as well as lifting.

Crane

This is a No. 1-A Crane. It also is attached to a tractor. It can be used to lift and carry many things about the farm. The farmer uses it to carry such things as fencing materials, watering troughs, feeding troughs, and the like.

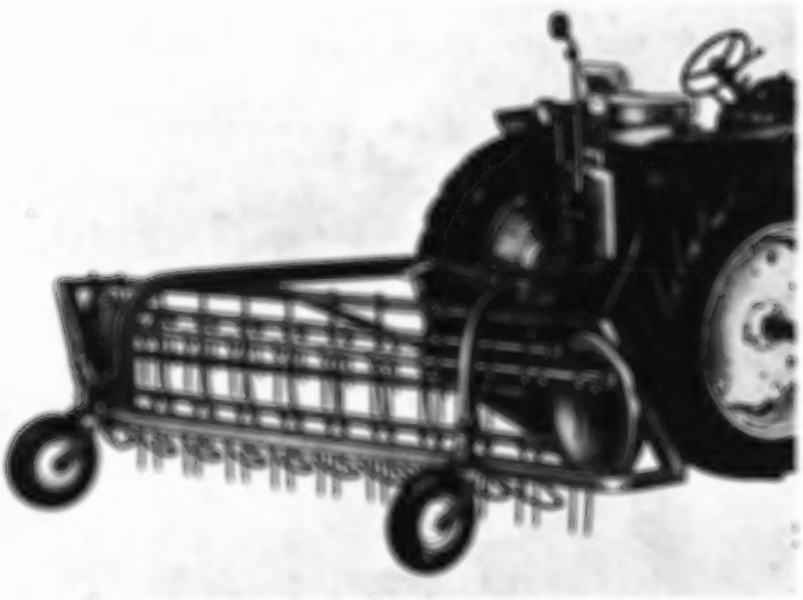
Mower

There are many kinds of mowers. They are used for cutting grass or crops in fields. Some mowers are mounted behind the tractor and others are mounted at the side. Different models are used for different kinds of field conditions.



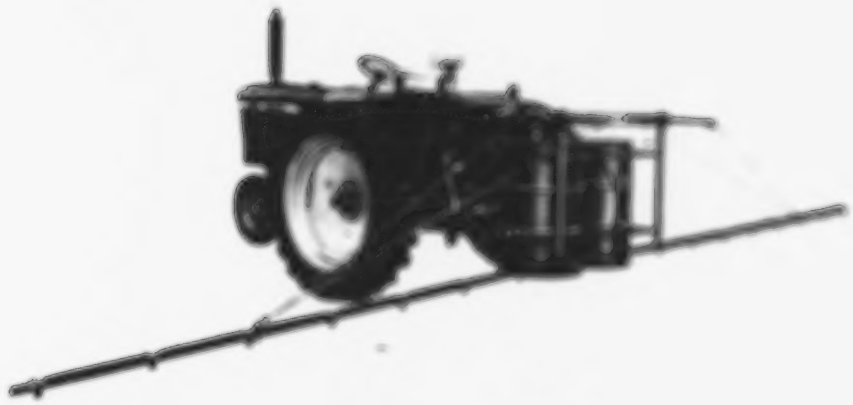
Hay Stacker

This is a 52 Stacker designed to handle loose hay. It can also handle bales of hay. Standard equipment includes nine-foot teeth and self-leveling features. One lever controls the basket lift, tilt, and float. Another is used to push off the hay.



Rake

Rakes may also be attached to tractors. The 350-A PTO Side-Delivery Rake is only one of the many types in use today. (PTO stands for power take-off.) The teeth of this rake are specially constructed to go over or around field obstructions, such as stumps or large rocks.



Sprayer

The John Deere 10 and 20 Sprayers are equipped with wide-spray jets or six-row or eight-row booms. They are used to spray row crops, pastures, vegetables, orchards, livestock, and buildings.

Corn Picker

This attachment, a 237 Corn Picker, picks corn at high speed working on two rows at a time. Ears of corn are separated from the stalks and the husks removed in one operation.

Fertilizer Distributor

The MLF Fertilizer Distributor shown here can also be used to spread fertilizer for small seed crops like cereal grain, grass, and vegetables.

Cotton Picker

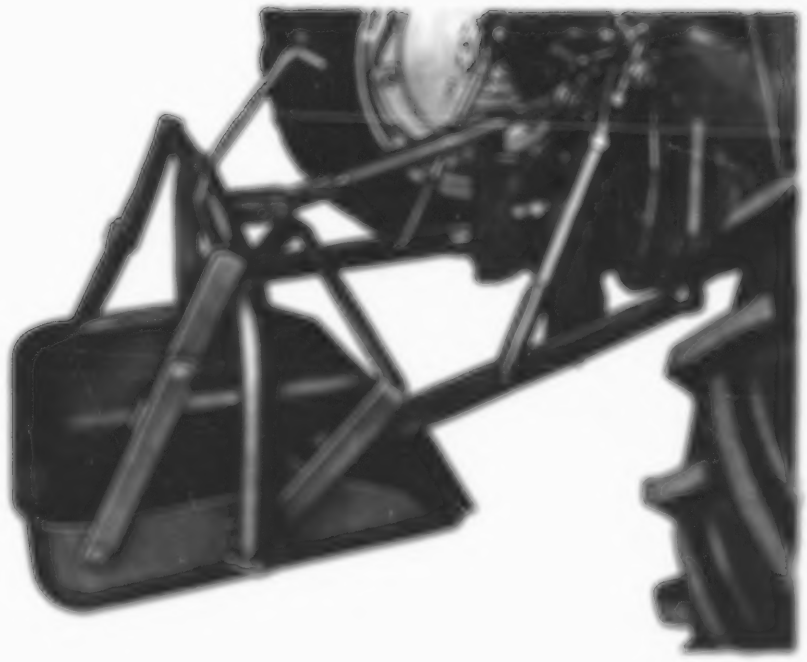
The 277 Brush-Type Cotton Stripper strips cotton from two rows at a time. It can harvest tall, heavy cotton at speeds up to five miles per hour. The cotton stalks go between two flexible rollers, which have rubber flaps between each set of nylon brushes. This machine picks the cotton balls.

Quik-Tatch Planters

There are two kinds of Quik-Tatch planters. The 246 is used to plant two rows, and the 446 to plant four rows. They will plant any smooth seed like corn, beans, or cotton.

Quik-Carrier

The 12 Quik-Carrier is not only a good cultivator, but also a front-mounted farm tool carrier. This equipment can be used to cultivate such different crops as narrow rows of vegetables or wide rows of corn, cotton, and beans.



Scoop

The 20 Rear-Mounted Scoop is used for earth moving. It is very useful for filling in hog wallows. It can also be used to clean irrigation ditches and feedlots. The scoop can also be used for light maintenance work on yards or roads. The scoop can pick up seven and a half cubic feet of earth at one time.

Snow Plow

The 42 Snow Plow is designed to remove snow rapidly. It can also be used for light earth levelling. The blade is 25 inches high and six or seven feet wide. The blade can be lifted by the operator and can be used either angled or straight.

ACKNOWLEDGMENTS

This is an experimental booklet intended to help young people learn more about the uses of hand and power tools and the principles under which they operate. It is hoped that students will find the booklet useful and stimulating, and will learn important information about the basic principles, concepts, and applications of mechanics and technology.

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It was prepared by Clinton A. Weyman, Jr., Assistant Research Professor of Education, and Mrs. Grace C. Alexander, Research Scientist, under the direction of Dr. John F. Dailey, Research Professor of Education. Mrs. Louise O. Vincent provided editorial assistance. Mr. Bernard Blumberg designed the cover and assisted in the layout.

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Comments and suggestions about the booklet will be appreciated. Address all correspondence to:

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